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II
**EXPEDITION TO THE REVILLAGIGEDO ISLANDS,
MEXICO, IN 1925, II**

MIOCENE MARINE DIATOMS FROM MARIA
MADRE ISLAND, MEXICO

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The diatoms described in the following paper were collected in May, 1925, by G. Dallas Hanna and Eric K. Jordan, members of the expedition sent out by the California Academy of Sciences. The collection consists of many samples of diatomite of high purity, obtained in the east bank of Arroyo Hondo, a large wash which empties into the sea on the north end of Maria Madre Island, one of the Tres Marias Group, off the west coast of Mexico. The exposures are about two to three miles inland from the shore.

The diatomaceous shales outcrop here and there for a considerable distance along the creek and it was estimated that the thickness of the deposit was close to 1000 feet, the dips being from 15° to 30° and in general northerly direction. Above the diatomite, Pliocene sandstones and limestones with a thickness of approximately 400 feet have the same northerly

April 16, 1926

dip but the angles are only 5° to 10° . The diatomite rests directly upon a diorite base and this in turn upon massive granite.

On account of its stratigraphic position and the organisms it contained, the diatomite is believed to be Miocene in age. Many of the diatoms belong to species which have previously been found only in Monterey Shale of California. Others are characteristic of the Miocene deposits of Maryland and Virginia. This mingling of floras might be expected to occur in the Miocene when the Isthmus of Panama did not exist.

The Maria Madre Island deposit has little in common with the famous beds of Barbados and Trinidad which have yielded so many strange forms. They are probably older.

The collection of slides upon which this report is based has been prepared according to the methods used by Dr. Albert Mann of Washington, D. C. One species only is mounted upon a slide. All type material is segregated in the Type Collection of the Department of Paleontology, California Academy of Sciences.

Other organisms found in the shales but which have not as yet been studied are fishes, radiolarians and silicoflagellates.

An alphabetical arrangement of genera and species has been adopted, thus obviating the need of an index. Names of genera in common use among diatomists have been retained even though some of them might be replaced in accordance with the rule of priority adopted by many botanists and zoologists. Because of their refusal to foist this rule upon themselves it is believed that the generic nomenclature of the diatoms is more stable than in most other groups of organisms.

We are under deep obligations to Dr. Barton Warren Evermann, Director of the California Academy of Sciences, for unremitting generosity in the provision of instruments and library facilities whereby this study has been made possible. The literature on the diatoms is extensive and much of it is rare and expensive; in spite of this the Academy has succeeded in securing all of the most important books and papers on the subject from a taxonomic standpoint.

1. *Actinocyclus allinearius* Hanna & Grant, new species

Plate 11, figure 1

Valve large, circular, regularly convex in the center; border narrow; pseudonodule circular, hyaline and very distinct; surface markedly coscinodisciform, there being a small group of rather heavy closely-set beads in the center without definite arrangement; remainder of disk covered with closely-set radial rows of beads the size being such that a fairly accurate quinquex arrangement is maintained; close to the margin the radial lines of beads become striæ, difficult to resolve because of the sloping surface of the valve; a definite and accurate radial and quinquex arrangement of the beads is interrupted by pairs of rows extending outwardly varying distances and maintaining a considerably larger size to the termination, after which three rows of usual size continue outwardly; this difference in size of the beading and a small hyaline space left unfilled between the two rows immediately before they end produce a pyrotechnic effect seen in the common and well known *A. pyrotechnicus* Deby¹ from the Monterey Shale of California. Also under low magnifications and in oblique light the diatom presents a mottled effect, especially when slightly out of focus; this appears to be due to irregularities of the inner surface of the valve; at least no outward structure could be detected from which it could be formed. Diameter .1131 mm.

Type: No. 1871, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This species would seem to be little apt to be confused with any other although it bears a general resemblance to *A. pyrotechnicus* Deby. It lacks the hyaline central pore of the latter, and the shape is decidedly distinct as shown by the figures herewith. Fortunately we have a perfect specimen of *pyrotechnicus* from the Maria Madre Island deposit for comparison.

2. *Actinocyclus canestrus* Hanna & Grant, new species

Plate 11, figure 2

Valve with wide margin composed of closely-crowded beads in diagonally curved rows running in two directions at angles

¹ In Rattray, Journ. Quek. Micr. Club, ser. 2, Vol. 4, 1890, p. 144, pl. 11, fig. 15.

of about 60° to the radii; the beads of this zone are very minute near the margin and increase gradually in size inwardly and without a definite boundary; disk with 17 radial rows of round, large, closely-set beads, a short spine being at the marginal end of each row; remainder of the disk uniformly dotted with beads the same size as those of the rows but not arranged in any definite formation; a very small central blank area; ocellus very distinct and set a considerable distance from the actual margin of the valve. Diameter .0690 mm.

Type: No. 1872, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This species is definitely related to *A. ralfsi* but differs notably in the uniform beading on the disk and the absence of a definite boundary, inwardly, of the marginal zone of small beading.

3. *Actinocyclus cubitus* Hanna & Grant, new species

Plate 11, figure 3

Valve small, broadly but uniformly convex; surface divided into four parts; each 90° sector with rows of heavy beads uniformly spaced and parallel to those radii which bisect the sectors; boundary of each sector with a conspicuous spine at the margin; the center of one of the sectors marked with an ocellus; border wide and radiately striated. Diameter .030 mm.

Type: No. 1873, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This beautiful little species has no close relative that we have been able to find in the literature; the above is a description of the type specimen which is figured. Another in the collection is exactly the same in all details except that it is divided into six sectors instead of four. Since variation in number of sectors is a common occurrence among the *Actinocykli*, no significance is assumed to be represented by this difference.

4. *Actinocyclus pyrotechnicus* Deby

Plate 11, figure 4

Actinocyclus pyrotechnicus DEBY in RATTRAY, Journ. Quek. Micr. Club, ser. 2, Vol. 4, 1890, p. 144, pl. 11, fig. 15; "Santa Monica," California, from a piece of Miocene float.

One perfect specimen of this common California Miocene species was found in the Maria Madre Island deposit. This is fortunate because it affords an opportunity to compare with it *A. allinearius* n. sp. Rattray stated that the pseudonodule was "inconspicuous or problematical"; we can find no trace of the structure in our specimen. And this leads to speculation as to whether Schmidt's *Coscinodiscus micans*² from Oamaru, New Zealand, may not be the same. His figures show no pseudonodule and the structure otherwise is very similar to *A. pyrotechnicus*. If they should be the same then *micans* must take precedence because it was published a year earlier. We are not inclined to unite the two names because Rattray must have had Schmidt's plate in hand when he was preparing his paper, and if they were the same it seems very unlikely that he would have overlooked it. It is believed that Rattray's figure was drawn from the Hungarian specimen mentioned in the description of *pyrotechnicus* because there is seen a decidedly distinct pseudonodule, and this is inconsistent with his statement that the structure is "inconspicuous or problematical."

Diameter of specimen figured .2268 mm. (No. 1874, C.A.S. coll.)

5. *Actinocyclus rosoleo* Hanna & Grant, new species

Plate 11, figure 5

Valve circular, flat, very slightly depressed around the margin; margin narrow, smooth, bordered inside with a beaded zone twice the width of the margin; the beads are arranged in two rows as usual in this zone in many *Actinocyclus* such as *ralfsi*; from the beaded zone 62 rows of sparse set beads extending toward the center, the beads decreasing in size as the distance increases from the margin; in an indefinite central area

² Atlas Diat., pl. 139, figs. 2, 3, 1889.

the smallest beads become sparsely and irregularly arranged; pseudonodule very distinct and almost as wide as the border beaded zone. Diameter .080 mm.

Type: No. 1875, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The distinct and sparse radial rows of beads set this species off from any we have ever seen. The characters are so different from other forms that, although the specimens found are not perfect, they are believed to be sufficiently important to warrant description.

6. *Actinoptychus gallegosi* Hanna & Grant, new species

Plate 11, figure 6

Valve almost circular but very slightly flattened on three sides; border narrow and succeeded by an annular, beaded zone, in width almost equal to one-third the radius; sectors six, three being slightly wider than the others and these latter each have in one outer corner a short spine and in the other corner a hyaline area; each of the larger group of three sectors has in each outer corner a large hyaline area, pointed toward the center and outwardly forming the inner boundary of the marginal, annular, beaded zone; on the zone and radially very close to one of these hyaline areas is an ocellus similar to what is found in *Actinocyclus*; central area hyaline with border jagged; markings consist of sharp beads set in rows at right angles to each other on the sectors; beads of marginal annular zone slightly smaller than those of the sectors. Diameter .0928 mm.

Type: No. 1876, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is exactly intermediate between *A. gründeri* A. Schmidt³ and *A. pfitzeri* Gründler.⁴ Both of these species are described from California and presumably from the Monterey Shale at Monterey. It is possible all three forms are variations of a single species, but, in the absence of material to prove this,

³ Atlas Diat., pl. 1, fig. 22, 1874.

⁴ Op. cit., pl. 29, fig. 1, 1875.

its assumption is unwarranted. Schmidt devoted plate 90 of his Atlas to other modifications of the same group, but none of those figured approaches our specimens as closely as those named. In his form *A. gründleri minor*⁶ from "Santa Monica" Monterey Shale, he illustrates the fact that alternating segments even in the same diatom may bear one or two spines. The presence of the ocellus on the marginal zone is of important significance.

We take pleasure in naming this diatom after the late Professor José M. Gallegos, a distinguished naturalist of Mexico and a member of the Academy expedition of 1925.

7. *Actinoptychus glabratus* Grunow

Plate 11, figure 7

Actinoptychus glabratus GRUNOW, VAN HEURCK, Syn. Diat. Belg., Pl. 120, fig. 6, 1881.—SCHMIDT, Atlas Diat., pl. 153, figs. 7, 12, 1890.

A complete frustule,⁶ divided and mounted on one slide was found in the material from Maria Madre Island. We have hesitated somewhat in referring it to the above species although it is very close to Schmidt's figure 12, cited above, of a specimen from Guano in Peru; he made the identification questionably. The specimens bear a decided resemblance to *A. janischii* Grunow, (Van Heurck Syn. Diat. Belg., pl. 122, fig. 6, 1881; Schmidt, Atlas Diat. pl. 153, figs. 8-10, 21, 1890) and there seems no reason why they might not very properly come under that name if it be valid. We doubt the validity if *janischii* and *glabratus* has precedence; therefore we have used the latter name. The species from the Monterey Shale of California, originally figured under three varietal names by Grunow, is believed to be distinct. Dr. Mann,⁷ in 1907 recognized *janischii* as distinct and put *glabratus* as a synonym under *A. splendens*, but all available figures of the latter which he cited seem to be distinct from the other two names. Diameter of specimen figured, No. 1877 (C.A.S. coll.), .1376 mm.

⁶ Op. cit., pl. 100, 1886, figs. 3, 4.

⁶ The splitting of this frustule gives us an opportunity to state that the two valves are identical and there was no trace of an internal accessory plate.

⁷ Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, pp. 270, 271.



8. *Actinoptychus maculatus* Grove & Sturt

Plate 11, figures 8, 9

Actinoptychus vulgaris SCHUMANN var. *maculata* Grove & Sturt, Journ. Quek. Micr. Club, Ser. 2, Vol. 3, 1887, p. 64, pl. 5, fig. 5; Oamaru, New Zealand.—SCHMIDT, Atlas Diat., pl. 132, fig. 17, 1888.

Individuals of this species are not uncommon in the Maria Madre Island deposit. They have the heavy secondary beading, large spines as shown by Schmidt and ten sectors. He figures two other specimens from Oamaru, New Zealand (the type locality), one with eight rays and a much larger one with fourteen. Our specimen figured, No. 1878 (C.A.S. coll.), is .0338 mm. in diameter; another is .0368 mm. The photograph on plate 11 was taken with the focus so adjusted that the large maculations on the out-of-focus sectors do not show. Therefore the drawing has been added to indicate this feature.

9. *Actinoptychus perplexus* Hanna & Grant, new species

Plate 11, figures 10, 11

Valve circular, divided into six equal segments and a hexagonal hyaline area in the center; under moderate magnification the divisions between the segments appear as black bars and the disk is covered with an irregular mottling of black on light ground; with immersion objectives of N. A. 1.20 or more the disk is found to be covered uniformly with two layers of beads; one of these, the uppermost in the type specimen, consists of comparatively large rounded beads, rather indefinitely arranged in two sets of rows set diagonally to the radii; in the other set the beads are about half as coarse and are much more crowded, being poorly arranged in rows parallel to the radii; the outer margin of each segment bears a short spine in the center and one of the segments has a comparatively large ocellus. Diameter .0622 mm.

Type: No. 1879, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The photographs show the markings of this species well and they appear to be thoroughly diagnostic; they require considerable manipulation of the microscope for proper study.

10. *Actinoptychus solisi* Hanna & Grant, new species

Plate 12, figures 1-3

Valve circular with 14 to 18 sectors, each alternating one being provided with a short spine at the outer end; central area blank; markings in two series; first a set of large rounded protuberances, too massive to be called beads, arranged apparently in no very definite form and scattered uniformly but sparsely throughout the valve, the smooth central area excepted; the other set of markings consists of a series of small but distinct, round beads set in two series of rows at angles of about 50° with the radii and uniformly distributed over the ornamented area; outer ends of non-spine bearing sectors raised out of the plane of the remainder and therefore appearing as blank spaces in photographs. Diameter of type .1352 mm.; of paratype No. 1881 .0654 mm.; of paratype No. 1882 .190 mm.

Type: No. 1880; *paratypes* Nos. 1881, 1882, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species belongs to a group of which *A. incisa* Grunow is the form most familiar to western students, on account of its being a common species in the upper part of the Monterey Shale. But in no specimen of that species we have seen has there been more than a faint indication of the system of large secondary markings so evident on *A. solisi*. Moreover, *A. incisa* invariably has blank spaces of greater or less extent following the median lines of alternating sectors from the central hyaline area; *A. solisi* has none.⁸

The species is large and very handsome and we take pleasure in naming it for Sr. Ing. Octavio Solis, Director of the botanical garden of Chapultepec and a member of the Academy expedition of 1925.

⁸ See SCHMIDT, Atlas Diat., pl. 154, figs. 2, 3, (1890)—HANNA & GAYLORD, Bull. Am. Assoc. Petrol. Geol., Vol. 9, No. 2, 1925, pl. 4, fig. 1, (*A. incisa*.)

11. *Actinoptychus undulatus* (Bailey)

Plate 12, figure 4

Actinocyclus undulatus BAILEY, Amer. Journ. Sci. Arts, 1842, pl. 2, fig. 11.
Richmond, Virginia.—KÜTZING, Kieselshaligen Bacillarien, 1844,
p. 132, pl. 1, fig. 24.

Actinoptychus undulatus RALFS in PRITCHARD, Hist. Infusoria, 1861, 4th
ed., p. 839, pl. 5, fig. 88.—SCHMIDT, Atlas Diat., pl. 1, figs. 1-6, 1874.

The most common diatom in the Maria Madre Island deposit is an *Actinoptychus* which we have considered to be *undulatus*. The specimen figured is characteristic of the forms, and, although great variation was noted, this average-sized one is .0553 mm. in diameter. It is No. 1883 (C.A.S. coll.).

12. *Amphora crassa* Gregory

Plate 12, figure 5

Amphora crassa GREGORY, Diat. Clyde, p. 524, pl. 14, fig. 94.—SCHMIDT,
Atlas, Diat., pl. 28, fig. 16, 1875.

Our specimens from Maria Madre Island Miocene do not seem to differ from the above sufficiently to warrant specific separation. The one figured, No. 1884 (C.A.S. coll.), is .1174 mm. in length and .0192 mm. in breadth.

13. *Amphora maria* Hanna & Grant, new species

Plate 12, figure 6

Valve asymmetrical, crescentic, ends rounded knob-like; concave margin gently convex in the region of the central nodule; convex side with a zone of heavy, transverse, costæ, easily resolvable into beads under proper illumination; between this zone and the raphe there is a blank space followed by a row of coarse beads close to the raphe; on the concave side a row of heavy transverse costæ starts with each end but these decrease in length to finer and finer beads toward the central nodule which they do not reach. The type is .1080 mm. in length and .020 mm. in breadth.

Type: No. 1885, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The only species with which this striking form needs comparison is one illustrated by Schmidt⁹ from Campeche Bay, Gulf of Mexico, and which he stated was "perhaps a new species," but he did not name it. His figure 14, in particular, is very close to the specimen figured herewith. He compared these figures with *A. egregia* Ehrenberg,¹⁰ but an examination of the original figure of that species shows a hopelessly indeterminate diatom in zonal view. Wolle,¹¹ however, copied Schmidt's figures and referred them unconditionally to *A. egregia*. Under such circumstances no course is possible for us but to give our fossil a new name and recommend that the name *A. egregia* be put in the list of indeterminates.

14. *Arachnoidiscus manni* Hanna & Grant, new name

Plate 12, figures 7-9

- Arachnoidiscus ornatus montereiana* SCHMIDT, Atlas Diat., pl. 73, figs. 7-9, Jan. 28, 1882; type loc. "Monterey," California, Miocene. Not *A. ehrenbergii montereyana* SCHMIDT, Atlas Diat., pl. 68, fig. 2, July 20, 1881; type loc. "Monterey," California, probably living.
- Arachnoidiscus ornatus montereanus* HANNA & GAYLORD, Bull. Am. Assoc. Petrol. Geol., Vol. 9, No. 2, 1925, pl. 5, fig. 2.

This is a common fossil diatom in the Miocene Monterey Shale of California and has often been referred to as *A. ornatus*. Schmidt detected the differences and named it but unfortunately the name he gave had been used for a different form on an earlier plate and *montereiana* must pass into synonymy. Since it is a very important species and will unquestionably be often referred to we take pleasure in naming it after Dr. Albert Mann, the foremost diatomist of the United States.

It is believed that the photographs reproduced herewith give a better picture of this fossil form than any previous illustrations with the possible exception of those of Schmidt. As usual in the genus there is considerable variation but the minuteness of the beads is a distinguishing feature. The specimens figured from Arroyo Hondo, Maria Madre Island (Tres

⁹ Atlas Diat., pl. 28, 1875, figs. 13-15.

¹⁰ Abhand. Kon. Acad. Wiss. Berlin, 1872, fig. 20.

¹¹ Diat. N. Amer., pl. 3, figs. 20, 21, pl. 4, fig. 1.

Marias Group) are as follows: No. 1886 (type) diam. .1720 mm.; No. 1887, diam. .1840 mm.; No. 1888, diam. .100 mm.; (C.A.S. coll.).

15. *Asterolampra marylandica* Ehrenberg

Plate 13, figure 1

Asterolampra marylandica EHRENBURG, Ber. Akad. Wiss. Berlin, 1845, p. 76, f. 10.—BAILEY, Amer. Journ. Sci., Vol. 48, 1845, pl. 4, fig. B.—GREVILLE, Trans. Micr. Soc. London, n. s. Vol. 8, 1860, p. 108, pl. 3, figs. 1-4; Vol. 10, 1862, p. 44, pl. 7, figs. 1-3.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 273.

Individuals of what appears from the published figures to be this variable species occur not infrequently in the Maria Madre Island deposit. A few minor differences have been noted, but they do not appear to be of sufficient importance to warrant specific separation. *A. marylandica* originally was described from the Miocene deposit at Nottingham, Maryland, but has since been found widely distributed. The specimen figured, No. 1889 (C.A.S. coll.), is .0790 mm. in diameter.

16. *Asteromphalus dubius* Hanna & Grant, new species

Plate 13, figure 2

Valve divided into ten equal sectors with division ribs approximately equal in size; beaded zone equal to one-half the radius; the beads of each sector arranged in three rows 60° apart; rosette divided into 10 parts with heavy ribs between; these ribs are not radially straight and near the outer ends there are angular turns in various directions; two divisions of the rosette are larger than the others and these two meet in the center of the valve. Diameter .060 mm.

Type: No. 1890, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is distinct from all others known to us although closely approaching *A. moronensis* Greville,¹² from a deposit in Spain. That species has nine sectors, one of the dividing ribs

¹² Schmidt, Atlas Diat., pl. 38, fig. 24, 1876.

being narrower than the others, and the parts of the rosette are differently arranged. But the similarity of the rosette of both these and some other species to typical asymmetrical *Asteromphalus* has led us to include ours in that genus. It was unquestionably such intermediate forms as these that caused Greville to unite *Asteromphalus* and *Asterolampra* in one genus.

17. *Aulacodiscus margaritaceus* Ralfs

Plate 13, figures 3, 4

Aulacodiscus margaritaceus RALFS, PRITCHARD, Infusoria, 4th ed. 1861, p. 844; type locality, Patos Island guano, Gulf of California.—SCHMIDT, Atlas Diat., pl. 37, 1876, figs. 1-8; pl. 105, 1886, figs. 1, 4, 5.—WOLLE, Diat. N. Am. 1894, pl. 82, figs. 1-2.—EDWARDS, Trans. San Francisco, Micr. Soc. pt. 1, 1893, p. 13, 14; "Santa Monica," California, Miocene.

This species has been listed from the Miocene shales of California more than once; in fact, Schmidt's first figures (pl. 37, figs. 1-4) are from "California" and were published in 1876. We cannot find that Ralfs illustrated the species, and, if not, California should be considered the type locality because, without figures, the best descriptions of diatoms are almost worthless. At the date the Atlas was published European workers had received comparatively little material from California other than fossil and it seems fairly safe to assume that Schmidt's was the latter. Therefore, we are inclined to consider Monterey Shale as the original type material of this species, rather than that of Ralfs from the Gulf of California.

We have two perfect specimens from the Miocene deposit of Arroyo Hondo, Maria Madre Island. One has eleven spines and the other three, yet they seem to be the same; the number of spines in this genus is a dangerous criterion for the separation of species. The smaller specimen with three spines has practically no umbilicus, but specimens similar in this respect have been figured heretofore. The species is very convex in the center.

The specimen with three spines, No. 1891 (C.A.S. coll.), is .1114 mm. in diameter; the one with 11 spines, No. 1892, is .1476 mm. in diameter.

18. *Aulacodiscus rellæ* Hanna & Grant, new species

Plate 13, figures 5, 6

Valve circular, typically with five spines; each spine set in a hyaline area and this surrounded by a raised, convex ridge on which there are ridges, radial from the spine; central area circular and hyaline, with narrow, hyaline, radial areas to each spine; disk uniformly dotted with fine closely-set beads. The area enclosed by the spines and a narrow marginal zone between the spines have sparsely, irregularly, arranged beads about twice as large as those covering the disk; neither more nor fewer than five spines have been seen. Diameter .0539 mm.

Type: No. 1893, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Only three species are known to us with which this strange diatom needs comparison; *A. barbadensis* Ralfs¹³ is closest, but it has four spines only, the large, secondary beads are uniformly distributed over the disk and the spaces around the spines are radially marked only on the outer sides; in *A. rellæ* these spaces are marked completely around. *A. circumdatus* Schmidt,¹⁴ from the Monterey Shale of California, likewise has four spines, large secondary beads only in the center of the disk, and the marginal zone is marked with some heavy dark spine-like projections of silica. Another similar species is *A. notatus* Grove & Sturt,¹⁵ from the fossil deposit at Oamaru, New Zealand; this has four hyaline spaces, each with a spine and, like *A. rellæ*, with radial markings all around; some heavier beading is found in the central area but not elsewhere.

All three of the above mentioned species and *A. petersi* Ehrenberg, form a group in *Aulacodiscus*, set apart by the presence of large secondary beads on the disk.

The species is named for Mrs. Rella Grant in recognition of much assistance rendered in the preparation of the illustrations of this and other papers.

¹³ Schmidt, Atlas Diat., pl. 146, fig. 5, 1890.

¹⁴ Schmidt, Atlas Diat., pl. 35, fig. 5, 1876.

¹⁵ Journ. Quek. Micr. Club, Ser. 2, Vol. 3, 1837, p. 9, pl. 3, fig. 11.

19. *Auliscus caballi* Schmidt

Plate 13, figure 7

Auliscus caballi SCHMIDT, Atlas Diat., pl. 32, figs. 1, 2, 1875; Puerto Cabello.

We have picked out several valves of an *Auliscus* with three ocelli each and these are certainly very close to the form named by Schmidt. No differences which would warrant specific separation can be detected. This form appears to differ chiefly from *A. elaboratus* Ralfs¹⁶ in the presence of spines between the ocelli in *A. caballi* which are lacking in Ralfs' species from Barbados. Otherwise they are very similar indeed. The specimen figured, No. 1894 (C.A.S. coll.), is .0366 mm. in diameter.

20. *Auliscus cælatus* Bailey

Plate 13, figure 8

Auliscus cælatus BAILEY, Smith. Contr. Knowl., Vol. 7, 1854, p. 6, pl. 1, fig. 3-4.—SCHMIDT, Atlas Diat., pl. 32, 1875, fig. 15; "Monterey."—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 232.

Individuals which agree in almost every detail with the figure, cited above, by Schmidt and which he stated was typical *cælatus* of Bailey, are numerous in the Maria Madre Island deposit. Others tend to show some of the great variability described by Dr. Mann. The specimen figured, No. 1895 (C.A.S. coll.), is .10 mm. in greatest diameter; .0908 mm. in least diameter.

21. *Auliscus grunovii* Schmidt

Plate 13, figure 9

Auliscus grunovii SCHMIDT, Atlas Diat., pl. 30, 1875, fig. 14.—WOLLE, Diat. N. Am., 1893, pl. 79, fig. 11.

This coarsely-marked species is present in considerable numbers in the Maria Madre Island deposit. The original locality given by Schmidt is "Rio, Brasil." On a later plate¹⁷ he listed as a subspecies of it, "Californica" Grunow and in the index

¹⁶ Schmidt, Atlas Diat., pl. 67, 1881, fig. 4.

¹⁷ Schmidt, Atlas, pl. 89, 1886, fig. 8.

to the atlas Fricke says to compare both with *A. elegans* Greville, but it seems to us that Schmidt's original figure represents a distinct species. Our specimens could hardly be expected to agree more closely than they do, yet none of them indicates intergradation with either *elegans* Greville or *californica* Grunow or *californicus* Brun. The specimen figured, No. 1896 (C.A.S. coll.) is .0660 mm. in diameter and practically circular.

22. *Auliscus pruinosus* Bailey

Plate 13, figure 10

Auliscus pruinosus BAILEY, Smith. Cont. Knowl., Vol. 7, 1854, p. 5, pl. 1, fig. 5-8.—SCHMIDT, Atlas, Diat., pl. 31, 1875, figs. 6, 7, 11, 13-15; pl. 32, 1875, fig. 5, pl. 108, fig. 10.—MANN, Cont. U. S. Herb., Vol. 10, No. 5, 1907, p. 283.

Auliscus punctatus BAILEY, Smith. Cont. Knowl., Vol. 7, 1854, p. 5, pl. 1, fig. 9.—SCHMIDT, Atlas Diat., pl. 31, 1875, figs. 8, 9; pl. 67, 1881, figs. 7-8; pl. 89, 1886, figs. 14-17.

The figures cited above show considerable variation but, as Dr. Mann has pointed out, there seems to be no useful purpose served in attempting to divide them as Bailey did. So many intergradations occur that numerous specimens cannot be assigned to either form, *pruinosus* or *punctatus*, and under such circumstances union seems to be the logical course to take. The species in common in the deposit at Arroyo Hondo, Maria Madre Island. The specimen figured, No. 1897 (C. A. S. Coll.) is .0932 mm. in greatest diameter and .0860 mm. in least diameter.

23. *Biddulphia consimile* (Grunow)

Plate 13, figures 11, 12

Triceratium (Odontella) consimile GRUNOW, VAN HEURCK, Syn. Diat. Belg. 1885, pl. 108, fig. 2; "Santa Monica," California; from a piece of Miocene float.—EDWARDS, Trans. San Francisco Micro. Soc. pt. 1, 1893, p. 16, "Santa Monica."

Triceratium consimile GRUNOW, SCHMIDT, Atlas Diat., pl. 84, 1885, figs. 13, 14; "Campeche Bay," Gulf of Mexico.—WOLLE, Diat. N. Am. 1894, pl. 106, fig. 6; "Santa Monica," California.

We have one beautiful specimen and saw several others, somewhat fragmentary in the Miocene material from Arroyo

Hondo, Maria Madre Island. These agree fairly well with this species, originally described from the Miocene of California. The presence of the large spines at the corners makes it necessary to place it in the genus *Biddulphia*. In Grunow's original figure the cells are larger than in our specimens and the sides are a very little straighter. Each cell or bead is surrounded by a row of minute dots as Grunow showed. The specimen figured, No. 1899 (C. A. S. Coll.) is .1236 mm. long on each side.

24. *Biddulphia deodora* Hanna & Grant, new species

Plate 14, figures 1, 2

Valve quadrangular, sides concave, corners acutely rounded; border narrow and marked by numerous short spines; spinous corner processes marked with about six coarse dots; surface with numerous large square beads arranged in radial rows; a central circular area having a much fewer number. Length of each side of type .0340 mm.

Type: No. 1900, *paratype* No. 1901, Mus. Calif. Acad. Sci., from Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico; collected by Hanna & Jordan, May, 1925; Miocene.

The above is a description of the type specimen. A paratype containing five points and smaller marginal spines has been selected because the two appear to be the same species. These come closest to a small pentagonal form figured by Schmidt¹⁸ as *Triceratium antillarum* Cleve, but we do not find the definitely bounded circular space indicated for it.

25. *Biddulphia jordani* Hanna & Grant, new species

Plate 14, figure 3

Valve very small, triangular, margins almost straight, angles bluntly rounded; border zone very heavy as in *B. montereyi* (Brightwell)¹⁹; surface with sparse, very heavy beads, irregularly arranged except over the border zone where there are rows of three, each pointing toward center of valve; corners

¹⁸ Atlas Diat., pl. 99, 1886, fig. 14.

¹⁹ Schmidt, Atlas Diat., pl. 94, figs. 1-3, 1886.

without spines and ornamented with beads similar to the valve but growing progressively smaller, outwardly. Length along one margin, .0337 mm.

Type: No. 1898, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is apparently closest to *B. montereyi* but is much smaller and has far fewer markings on the valve. It is named for the late Mr. Eric Knight Jordan, at the time of his death assistant curator of paleontology, California Academy of Sciences, and a member of the Academy's expedition of 1925.

26. *Biddulphia penitens* Hanna & Grant, new species

Plate 14, figures 4, 5

Valve quadrangular, apices rounded, sides gently concave; margin narrow, hyaline; markings consist of rows of beads radiating from margin toward center, the rows being widely spaced and beads decreasing in size on the corners; about 15 rows of beads of uniform size on each side; the beads become much scarcer in the center of the valve where they form an indistinct rosette. Length of one side of type .0435 mm.; of paratype .070 mm.

Type: No. 1902, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is marked similarly to *B. parallela* (Greville) and its triangular forms,²⁰ but that species has convex margins instead of concave. The form named *B. parallela coloniensis* (Grunow), by Schmidt²¹ from Colon, Panama, comes closest to our specimens but the latter have much heavier beads and there is a decided break between the beading of the central zone and the remainder of the valve; such a division does not appear in Schmidt's figure.

27. *Biddulphia riedyi* Hanna & Grant, new species

Plate 14, figure 6

Valve, triangular, sides straight, angles acutely pointed; each corner is occupied by a blunt projection, densely but

²⁰ See Schmidt, Atlas Diat., pl. 75, 1882, figs. 3-5 and 11-12.

²¹ Atlas, pl. 81, 1885, fig. 1.

minutely beaded on top; border zone of each side with several dense, siliceous bars, irregular in shape, projecting inwardly; surface of valve sparsely covered with round, heavy beads; from the center of each side, a rounded elevated ridge projects inwardly, all three meeting in the center. Length of each side .140 mm.

Type: No. 1904, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This large and handsome species is related to few others that we can find. *Biddulphia tabellaria* (Brightwell) and the subspecies *diplosticta* Grunow²² are similarly constructed but differ greatly in details, particularly in the fine beading found on the surface of the valve and the lack of the three radiating ridges mentioned above at the end of the description. The two fossils, *B. dobreana novæ-selandiæ* (Grove & Sturt) and *B. majus* (G. & S.²³) from the deposit at Oamaru, New Zealand, are likewise similar in general construction but differ even more in detail.

The species is named for Messrs. Charles and Frank Riedy of San Francisco, in recognition of their long continued interest in microscopy and the former San Francisco Microscopical Society.

28. *Biddulphia tuomeyii* (Bailey)

Plate 14, figure 7

Zygoceros tuomeyii BAILEY, Amer. Jour. Sci. Arts, Vol. 46, 1843, p. 138, pl. 3, figs. 3-9.

Biddulphia tuomeyii (BAILEY) RALFS in PRITCHARD, Hist. Infus. 4th ed. 1861, p. 848, pl. 6, fig. 10.—SCHMIDT, Atlas Diat., pl. 118, figs. 1-7; pl. 119, figs. 1-7, 15-17, 1888.

If all of the various forms figured by Schmidt as *B. tuomeyii* are that species, then our Maria Madre Island ones are also, unquestionably. And since ours resemble those he gives from eastern north America, the type locality, more than any others, it is very likely that our identification is correct even though the assemblage be broken up into several species, ultimately.

²²Schmidt, Atlas Diat., pl. 77, 1882, figs. 1-5.

²³Schmidt, Atlas Diat., pl. 168, figs. 2, 5, 1891.

The specimen figured, No. 1905 (C.A.S. coll.), is .080 mm. in length, and .040 mm. in width when in the position in which it was placed when the photograph was taken.

29. *Campylodiscus prentissi* Hanna & Grant, new species

Plate 14, figure 8

Valve broad, almost circular in vertical view; deeply saddle-shaped; divided on each side of a median section into 10 wide compartments separated by simple bars of silica, curved toward each end of the valve and each one bifurcate on the outer end; median section with parallel sides formed by breaks in the transverse bars, which, however, continue across the middle; between each pair of bars at the side of the median section there is an oblong bead; no fine markings could be discovered with a numerical aperture up to .95. Length along median line of type .0426 mm.; breadth at right angles to median line .0422 mm.

Type: No. 1906, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This coarsely marked species is not recorded in any of the literature at our command, and is not closely approached by any other. It has been named for Mr. Charles W. Prentiss of San Francisco, California, an enthusiastic preparer of diatoms.

30. *Cerataulus imperator* Hanna & Grant, new species

Plate 14, figure 9

Valve broadly oval, very convex, border narrow; horns long cylindrical, blunt and hyaline on top; spines absent; disk covered with heavy beading arranged radially near the margin but irregularly elsewhere; the beads over the greater portion are grouped in such a manner that the valve has a disorderly reticulate network-appearance under low magnification, markings similar in many ways to those of *Eupodiscus rogersii*. Length .1264 mm.; breadth .0936 mm.

Type: No. 1907, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Individuals of this huge, coarsely-marked species were rarely found in the Maria Madre Island deposit; they seem to require no close comparison with other forms for recognition.

31. *Cocconeis contrerasi* Hanna & Grant, new species

Plate 14, figure 10

Valve broadly oval with raphe greatly sigmoid; central and terminal nodules minute; densely and uniformly beaded over the disk, the beads arranged in somewhat radial rows; border narrow. Length .0391 mm.; breadth .0340 mm.

Type: No. 1908, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This beautiful species belongs to the group of which *C. dirupta* Gregory is perhaps the most common representative, but the differences are very evident upon comparison with such figures as Schmidt's.²⁴

The species is named in honor of Professor Francisco Contreras, a distinguished naturalist of Mexico and a member of the Academy's expedition of 1925.

32. *Cocconeis triumphis* Hanna & Grant, new species

Plate 14, figures 11-13

Valve broadly ovate with narrow hyaline border; raphe, a narrow lanceolate blank area reaching to the ends and crossed at the center with a transverse and narrower blank strip; otherwise the disk is covered with fine beads uniformly distributed in rows, radiating irregularly from the median area toward the margin, but, before reaching the latter, the beads assume positions in diagonal rows of various angles and directions producing chiefly a wavy appearance. Length of type specimen .0620 mm.; breadth .0461 mm.; length of paratype (No. 1910) .0347; breadth .0270 mm.

Type: No. 1909, *paratypes* Nos. 1910, 1911, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

²⁴ Schmidt, Atlas Diat., pl. 197, figs. 31-34, 1895.



The characters in general are the same as those of a fossil from Sendai, Japan, called *C. formosa* Brun by Schmidt,²⁵ but the beading of the Maria Madre Island species is very much finer and the rows radiate from the central area only part way to the border; the outer zone has the beads in rows which take various diagonal directions.

33. *Coscinodiscus curvatus* Grunow

Plate 15, figure 1

Coscinodiscus curvatus GRUNOW; SCHMIDT, Atlas, Diat., pl. 57, 1877, Fig. 33; "Monterey," California; probably from a Miocene fossil deposit.

Apparently the fossil deposit at Monterey, California, is the type locality of this species and our specimens from the Miocene of Maria Madre Island could hardly come closer to perfect agreement with the figure in Schmidt's Atlas than they do, although his figures from other localities are not so close. The curved radial rows of beads dividing the disk into sectors and the additional rows in each sector parallel to the division row are very characteristic features, possessed by no other diatom than this group. Differences in living specimens from other localities pertain to width of border and size of beads, both characters of relatively little value in this group.

Diameter of specimen figured (No. 1912, C.A.S. coll.) .0658 mm.

34. *Coscinodiscus elegantulus* Greville

Plate 15, figure 2

Coscinodiscus elegantulus GREVILLE, Trans. Micr. Soc. London, Vol. 9, n. s. 1861, p. 42, pl. 4, fig. 8.—SCHMIDT, Atlas Diat., pl. 58, 1877, figs. 3-5; Barbados.

This remarkable diatom is not uncommon in the Miocene deposit on Maria Madre Island. Its chief distinguishing feature is the excentrically placed central area. Diameter of specimen figured (No. 1913, C.A.S. coll.) .0558 mm.

²⁵ Schmidt, Atlas Diat., pl. 193, fig. 47, 1894.

35. *Coscinodiscus evermanni* Hanna & Grant, new species

Plate 15, figure 3

Valve circular, large and heavy; central area depressed below a huge rounded marginal zone the diagrammatic cross section being as shown in figure 1; there is no suture between



Fig. 1. Diagrammatic cross section of *Coscinodiscus evermanni*, n. sp.

central and marginal areas as in *Craspedodiscus* and no break in the arrangement of the markings as in *Creswellia*; coarse markings arranged essentially as in *C. radiatus*, these being a group of slightly larger beads in the center but no central pore; each bead on the marginal zone has a circle of fine punctae or secondary markings as in *C. asteromphalus* and many other species, but no such structures could be found on the beads of the central area with a 4 mm. (N. A. .95) objective; the hoop connecting the valves is marked with beads of uniform size set in diagonal rows, at 90°. Diameter of type .1556 mm.; width of central area about .10 mm.; diameter of largest paratype .1564 mm.; diameter of smallest paratype .1176 mm.

Type: No. 1914, *paratypes* Nos. 1915, 1916, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This robust species is very common in the deposit on Maria Madre Island but perfect specimens are hard to find; the large size causes most of the valves to be broken, either in the bedding or in the cleaning processes. Hoops are abundant but almost always detached from the valves. The species is a connecting link between *Coscinodiscus* and *Craspedodiscus* and is much like *Craspedodiscus coscinodiscus* Ehrenberg²⁰ but the central zone in that form is much narrower. We have included it in *Coscinodiscus* because of the lack of a definite

²⁰ Schmidt, Atlas Diat., pl. 66, 1881, figs. 3, 4.

suture between central and marginal zones which is typically developed in *Craspedodiscus*. The edge of the valve is turned down at right angles to the disk as in *Endyctia*; thus a complex of characters is displayed which makes a correct generic assignment almost impossible.

The type slide contains three fairly complete specimens, which show approximately the variation in size.

The species is named for Dr. Barton Warren Evermann, Director of the California Academy of Sciences, who was responsible for the organization and despatch of the expedition of 1925 to West Mexican Islands.

36. *Coscinodiscus fasciculatus* Schmidt

Plate 15, figure 4

Coscinodiscus fasciculatus SCHMIDT, Atlas Diat., pl. 57, 1877, figs. 9, 10; "Cuxhaven."

This species, according to Schmidt's figures, has the beading arranged in radial rows and also there is produced a "watch case milled" effect similar to *C. radiatus*; in addition, there are some radial "pyrotechnical" markings as in *Actinocyclus pyrotechnicus*, thus making an exceedingly beautiful diatom. The species appears to be rare in the Maria Madre Island deposit. Diameter of specimen figured, No. 1917 (C.A.S. coll.), .0687 mm.

37. *Coscinodiscus hertleini* Hanna & Grant, new species

Plate 15, figure 5

Coscinodiscus concavus EHRENBERG, SCHMIDT, Atlas Diat., pl. 59, 1877, fig. 16; "Monterey," California; probably from a Miocene fossil deposit. This figure, Dr. Mann stated, does not belong to *C. concavus* of Ehrenberg (Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 248).

Valve flat, coarsely marked with a network of hexagons, the size of these decreasing slightly at the margin; the disk is roughly divided into sectors by a few almost straight radial rows, the remaining rows in the sector being approximately parallel to the central radial; this makes a secondary series of rows of beads in parallel arcs which cut the margin of the

valve; border narrow and transversely marked. Diameter of type .0480 mm.

Type: No. 1918, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

In the arrangement of the details of markings this species falls in with *C. denarius* Schmidt²⁷ from the fossil deposit of Barbados, West Indies. The markings of that form, however, are much finer and no described species in the same group can be found which is so coarse as the Maria Madre Island one. The markings of the new species are as coarse as in *C. heteroporus* or *C. radiatus*, but these appear never to have the peculiar arrangement of beads of the *C. denarius* group.

The species is named for Mr. Leo G. Hertlein, of the Department of Paleontology, California Academy of Sciences.

38. *Coscinodiscus lineatus* Ehrenberg

Plate 15, figure 6

Coscinodiscus lineatus EHRENBURG, Phys. Abhl. Akad. Wiss. Berl. 1838, p. 129 [1840].—EHRENBURG Microg. 1854, pl. 18, fig. 33; pl. 22, fig. 6 a-b; pl. 35 A, group 16, fig. 7.—SCHMIDT, Atlas Diat., pl. 59, 1877, figs. 26-32.—WOLLE, Diat. N. Am. 1894, pl. 87, fig. 10.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, p. 253.

This species is found frequently in the Miocene deposit on Maria Madre Island, but the valves are so delicate that perfect specimens can hardly be found. The width of the border and the development of the marginal spines in the species is subject to considerable variation as Dr. Mann has pointed out. Diameter of specimen figured, No. 1919 (C.A.S. coll.), .100 mm.

39. *Coscinodiscus marginatus* Ehrenberg

Plate 15, figure 7

Coscinodiscus marginatus EHRENBURG, Phys. Abhl. Akad. Wiss. Berl. 1841, p. 142 (1843).—EHRENBURG, Microg. 1854, pl. 18, fig. 44; pl. 13, group 12, fig. 13; pl. 38 B, group 22, fig. 8.—SCHMIDT, Atlas Diat., pl. 62, 1877, figs. 1-5, 9, 11, 12.—WOLLE, Diat. N. Am. 1894, pl. 94, fig. 21; pl. 112, fig. 8.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 253, pl. 49, fig. 2.

²⁷ Atlas Diat., pl. 57, 1877.

Although some of our specimens from the Miocene deposit of Maria Madre Island have narrower borders than Schmidt and others have usually shown in their figures, agreement otherwise is so close that we feel justified in making the identification. This is particularly true in view of the confusion so often pointed out in this group of *Coscinodiscus*. Diameter of specimen figured (No. 1920, C.A.S. coll. smaller than average) .0357 mm.

40. *Coscinodiscus masoni* Hanna & Grant, new species

Plate 15, figure 8

Valve circular, very convex, margin rather broad; markings consist of small, closely-set beads arranged in 13 sectors; each sector has a central radial row of beads extending from the center of the valve to the margin; all the other rows of beads in each sector are parallel to this central one; in the center of each sector and just inside of the border there is a blunt spine, shown as a white spot in the photograph. Diameter .1154 mm.

Type: No. 1930, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This strange species does not seem to resemble very closely any other that has been found. The arrangement of the beads in definite sectors is a very striking feature and so is the great convexity of the valves.

The species is named for Mr. H. L. Mason, the botanist of the Academy's Expedition of 1925.

41. *Coscinodiscus nitidus* Gregory

Plate 15, figure 9

Coscinodiscus nitidus GREGORY, Trans. Roy. Soc. Edinburgh, Vol. 21, 1857, p. 27, pl. 2, fig. 45.—SCHMIDT, Atlas Diat., pl. 58, 1877, figs. 17-19; Campeche Bay, Gulf of Mexico.

We have a beautiful specimen from the Maria Madre Island deposit that appears to be this coarsely-marked species from the Gulf of Mexico. It is hardly to be confused with any other *Coscinodiscus* except the one Rattray has named *C. sub-*

*nitidus*²⁸ from the Barbados fossil deposit. This latter does not appear to deserve separation from *C. nitidus*. Diameter of specimen figured (No. 1921, C.A.S. coll.) .0314 mm.

42. *Coscinodiscus nitidulus* Grunow

Plate 15, figure 10

Coscinodiscus nitidulus GRUNOW, SCHMIDT, Atlas Diat., pl. 58, 1877, fig. 20; "Campeche Bay," Gulf of Mexico.

A single specimen of this delicate diatom was found in the Maria Madre Island Miocene material. It differs from Schmidt's figure only in having the beads roughly arranged in radial rows while in his they are more or less in zones, there being three radial rows in each. But since the arrangement is not well marked in either form it is believed to be unimportant. Diameter of specimen figured (No. 1922, C.A.S. coll.) .0475 mm.

43. *Coscinodiscus oculus-iridis* Ehrenberg

Plate 15, figure 11

Coscinodiscus oculus-iridis EHRENBURG, Phys. Abh. Akad. Wiss. Berl. 1839, p. 147 (1841).—EHRENBURG, Microgeologie 1854, pl. 18, fig. 42, pl. 19, fig. 2.—SCHMIDT, Atlas Diat., pl. 60, 1877, fig. 17; pl. 63, 1877, figs. 4, 6-9; pl. 113, 1888, figs. 1, 3-5, 20.—MANN, Cont. U. S. Nat. Herb., Vol. 10 No. 5, 1907, p. 256.

A few typical specimens of this widely-spread species were found in the Maria Madre Island Miocene deposit. They appear to be identical with the form Grunow called *C. oculus-iridis morsiana*²⁹ but for which there seems to be little reason for acceptance. The subspecies originally came from Miocene material from Santa Monica, California. Diameter of specimen figured, No. 1923 (C.A.S. coll.), .1454 mm.

²⁸ See Schmidt, Atlas Diat., pl. 58, 1877, fig. 16, and Fricke's Index to same, 1902, p. 7.

²⁹ Schmidt, Atlas Diat., pl. 60, 1877, fig. 7; see Fricke, Index to Atlas, 1902, p. 7.

44. *Coscinodiscus pacificus* Grunow

Plate 16, figure 1

Coscinodiscus pacificus GRUNOW, SCHMIDT, Atlas Diat., pl. 60, 1877, fig. 13; the identification of this figure from Barbados is by Fricke in the Index to the Atlas, 1902, p. 7.

Specimens from the deposit on Maria Madre Island agree perfectly with Schmidt's figure named above by Fricke. Four rather large beads form a slight rosette in the center and this seems to be the only distinguishing feature between *C. pacificus* and *C. radiatus* Ehrenberg. This group of *Coscinodiscus* is difficult to understand and there can be no doubt but that too many names have been and are still being used. Diameter of specimen figured (No. 1924, C.A.S. coll.) .1296 mm.

45. *Coscinodiscus radiatus* Ehrenberg

Plate 15, figure 12

This and various other so-called species of this section of the genus are very difficult to decipher, but under *C. radiatus* we have placed those coarsely-marked specimens from Maria Madre Island with radial rows of beads, a "watch case milled" effect, and no central pore or rosette of large beads in the center. When this rosette is present and the "milling" still perfect the diatoms appear to have been placed under *C. oculus-iridis*; *C. pacificus* appears to differ from the latter only in the imperfect "milling" arrangement of the markings. Diameter of specimen figured (No. 1924, C.A.S. coll.) .0628 mm.

46. *Dicladia pylea* Hanna & Grant, new species

Plate 16, figures 4, 5

Valve view of frustule a regular, elongated oval, with one conical projection in the center of one valve, this projection being rounded on the tip; the other valve has two conical projections equal in size and with some irregular branches of silica at the tops. Major diameter .0678 mm.

Type: No. 1928, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species occurs frequently in the Maria Madre Island deposit; all other members of the genus known to us are much longer in zonal view than this one.

Mangin⁸⁰ has stated that the various forms of *Dicladia* are only *stato-spores* of diatoms, normally belonging to other genera. In a fossil deposit, however, the determination of the parent species becomes problematical and it seems best, for the present at least, to record the *Dicladia* as distinct.

47. *Dictyoneis marginata* (Lewis)

Plate 16, figure 8

Navicula marginata LEWIS, Proc. Acad. Nat. Sci. Phila, 1861, p. 64, pl. 2, fig. 1.

Dictyoneis marginata (LEWIS), CLEVE, Le Diatomiste, Vol. 1, 1890, p. 16.—SCHMIDT, Atlas Diat., pl. 160, 1890, fig. 1.—CLEVE, Kongl. Sv. Vet. Akad. Hand., Vol. 26, 1894, p. 30.—VAN HEURCK, Treat. Diat. 1896, p. 157, fig. 29.

Several specimens of this elegant diatom were found in the Maria Madre Island deposit. They are very similar in every way to what Cleve and Schmidt have called "form *typica*." Cleve placed nine species in the genus *Dictyoneis* and under *marginata* he placed seven named subspecies; the species must therefore be very variable although our specimens do not indicate this. For *typica* he gives the following widely separated localities: Mediterranean Sea; Levant; Delaware (type locality); Florida; West Indies; Colon; Gulf of Mexico; Java; all living; and fossil at Szakal, Hungary. Other named forms were listed from the fossil deposits of New Zealand and Japan, but this is apparently the first record of any member of the genus from the eastern Pacific. Although the general dismemberment of the genus *Navicula* as proposed by Cleve is not acceptable to most diatomists, *Dictyoneis* is so different from the usual form that the retention of that name seems to be justified. Length of specimen figured (No. 1929, C.A.S. coll.) .1240 mm.; breadth .030 mm.

⁸⁰ Rev. Sci. 1912, pp. 481-487.

48. *Endyctia robustus* (Greville)

Plate 16, figures 2, 3

Coscinodiscus robustus GREVILLE, Trans. Micr. Soc. London, n. s., Vol. 14, 1866, p. 3, pl. 1, fig. 8.—SCHMIDT, Atlas Diat., pl. 62, 1877, figs. 16, 17.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 258, pl. 48, fig. 4.—MANN, U. S. Nat. Mus. Bull. 100, Vol. 6, pt. 1, 1925, pp. 67, 68.

Dr. Mann has stated in his 1925 paper on Philippine Diatoms that this species belongs to *Endyctia* and not *Coscinodiscus*. A study of specimens from the Miocene fossil deposit at Monterey, California, the type locality, leaves little room for doubt as to the correctness of this disposition. Our specimens from Maria Madre Island Miocene are unquestionably the same as those from Monterey in our collection. Great variation in size is shown. The smaller specimen figured (No. 1926, C.A.S. coll.) is .0974 mm. in diameter; the larger (No. 1927) is .100 mm. in diameter.

49. *Eupodiscus rogersii* (Bailey)

Plate 16, figures 6, 7

Podiscus rogersii BAILEY; Amer. Journ. Sci. Arts, Vol. 46, Dec. 1843, p. 138, fig. 12.
Eupodiscus rogersii (BAILEY), EHRENBERG, Abh., Berlin Akad., 1844, p. 81.—SCHMIDT, Atlas Diat., pl. 92, 1886, figs. 2-6.—WOLLE, Diat. N. Am. 1894, pl. 76, fig. 3.

Individuals of a species we believe to be this are common in the Maria Madre Island deposit and have four to six spines. The form was originally described from the Nottingham, Maryland, fossil deposit. Diameter of specimen figured with four spines (No. 1931, C.A.S. coll.) .1242 mm.; diameter of specimen figured with six spines (No. 1932) .1646 mm.

50. *Glyphodesmus driveri* Hanna & Grant, new species

Plate 16, figure 9

Valve elongate, naviculoid in shape, rounded terminally and gently convex medially; terminal and central nodules rounded knobs, the latter being the larger; two rows of large quadrangular beads on each side of the pseudo-raphe; these may

be considered as transverse costæ divided in two parts longitudinally, with three or four on each side of the central nodule divided into three parts (in another specimen the longitudinal rows number three through the valve on each side of the central area); pseudo-raphe very distinct and almost equal in width throughout. Length of type .0962 mm.; breadth .0117 mm.

Type: No. 1933, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This elegant species is similar to only one known to us, *G. marinum* (Ralfs), which has the transverse costæ broken into four beads, is more pointed terminally and less convex medially.

The species is named for Mr. Hershel L. Driver, of Los Angeles, California, an enthusiastic student of microorganisms.

51. *Glyphodesmus sigmoideus* Hanna & Grant, new species

Plate 16, figure 10

Valve slightly asymmetrical, swollen at each end and slightly convex in the center; central and terminal nodules distinct; pseudo-raphe distinct and sigmoid in shape corresponding to the asymmetry of the valve; markings consist of about 50 heavy transverse costæ on each side of the pseudo-raphe, each one being broken irregularly into beads. Length of type .0520 mm.; breadth at end .0079 mm.; at center .0061 mm.

Type: No. 1934, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

G. williamsoni W. Smith²¹ appears to be the closest related species to this, but that form is much less swollen terminally, is not convex in the center, and lacks the slight but constant sigmoid outline of the form being described. Very few valves were found, but probably most of them were lost in the cleaning operations due to their small size.

²¹ Wolle, *Diat. N. Am.*, 1894, pl. 45, figs. 23, 24.

52. *Grammatophora merletta* Hanna & Grant, new species

Plate 16, figures 11, 12, 14

Valve elongate, sides approximately parallel, very slightly swollen in center; ends expanded, somewhat capitate; border heavy, and greatly thickened at each end; central area oval with the long axis parallel to the sides; markings consist of parallel, horizontal rows of dots, 35 in .01 mm., on each side of an exceedingly thin median line; the dots are also arranged in quinquex; these markings are exceedingly minute and difficult to resolve, the best optical equipment and monochromatic green or blue light being required to bring them well into view in styrax mounts; in girdle view the long bars of silica are straight throughout most of their length, there being one slight curve at each end. Length of type .0763 mm.; breadth .1010 mm.

Type: No. 1935, *paratype* No. 1970a, Mus. Calif. Acad. Sci., from Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico; collected by Hanna & Jordan, May, 1925; Miocene.

This species is abundant in the Maria Madre deposit and retains its distinctive characters constantly. These consist chiefly in the capitate ends and the excessively fine beading. It is undoubtedly closely related to *G. macilenta* and *G. maxima*³² but neither of these have capitate ends. Of all species of the genus known to us only *macilenta* or its relative *subtilissima* has such excessively fine markings.

53. *Hemidiscus niveus* Hanna & Grant, new species

Plate 17, figure 1

Valve very large, thin and delicate, broadly cuneiform; ends bluntly rounded; median portion of short margin convex, space between this and ends slightly concave; girdle very thick on one side in zonal view; disk uniformly marked with small beads arranged like the milling on a watch case but with irregular separation into radial sectors from the center; a distinct ocellus near the center of the short margin and with a

³² See Van Heurck, Syn. Diat. Belg., 1881, pls. 53, 53 bis.

row of small spines on each side extending to the ends but not around the long, rounded margin. Length of type .1516 mm.; breadth .1030 mm.

Type: No. 1936, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This huge species is exceedingly abundant in the Maria Madre Island deposit but the valves are so delicate that perfect specimens are very difficult to secure. It belongs to the group once named *Palmeria* Greville,³³ but which is not believed to be separable from *Hemidiscus* proper.³⁴

54. *Hemidiscus simplicissimus* Hanna & Grant, new species

Plate 16, figure 13

Valve with margin convex throughout, greatly thickened on one (dorsal) side; ends not produced; ventral side regularly rounded, with an ocellus near the margin but no spines; disk covered with close-set beading, which is largest in the center and decreases in size gradually to the margins; beads not arranged in radial rows but somewhat like watch case milling; border zone narrow and crossed by fine radial lines. Length of type .050 mm.; breadth .0366 mm.

Type: No. 1937, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

In the absence of radial rows of beads and projecting (gibbous) ends this species differs from the well-known *Euodia gibba* Bailey (*H. cuneiformis* Wallich); it is found commonly in the Maria Madre Island deposit. A species found in the Monterey Shale of California is very similar to this and may be the same; it has been referred to *H. gibba* or *H. cuneiformis* in the past, but an examination of the original figures of these³⁵ shows that, while they are probably one and the same as most authors³⁶ have contended, they can hardly be the same as these fossils unless an enormous amount of variation from the type be admitted.

³³ Ann. Mag. Nat. Hist., 1865, p. 2, figs. 1-4.

³⁴ For a discussion of the relationship of this group see Mann, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 316.

³⁵ Bailey in Pritchard, Hist. Infus. ed. 4, 1861, p. 852, pl. 8, fig. 22; Wallich, Trans. Mic. Soc. London, 1860, p. 42, pl. 2, figs. 3, 4.

³⁶ See Mann, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, pp. 316, 317.

55. *Melosira sulcata* Kützing

Plate 17, figure 2

There appears to be no adequate means for the separation of the many variations of *Melosira* which center around the name *sulcata*. No two valves ever appear to be exactly alike and it has been said that even in the same chain of individuals there are differences. Our Maria Madre Island specimens are exceedingly beautiful and differ from the published figures in certain details, but they differ among themselves just as much. Diameter of specimen figured (No. 1938, C.A.S. coll.) .0856 mm.

56. *Navicula ardua* Mann

Navicula ardua MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 336, pl. 53, figs. 2, 3; 864 fms. off Central California.

Our specimens agree precisely with the description and figures of this species from Campeche Bay, Gulf of Mexico, we can find no other described form with which it can be united. As he pointed out, the costæ are strictly unbeaded and therefore the specimens are not admissible with such as *N. pennata* or *N. longa*. One of our Maria Madre Island specimens is .0529 mm. long and .010 mm. wide.

57. *Navicula californica* Greville

Plate 17, figures 3, 4

Navicula californica GREVILLE, Edinburgh New Phil. Journ., Vol. 10 n. s., 1859, p. 29, pl. 4, fig. 5.—SCHMIDT, Atlas Diat., pl. 3, 1874, fig. 16.—WOLLE, Diat. N. Am. 1894, pl. 14, fig. 17.

Specimens which agree in general with the above figures are not rare in the Maria Madre Island deposit. The zones of beading shown in our figure are there represented as lines, but this may perhaps have been due to imperfections in the early objectives. Also the figures cited show the hyaline area stippled with dots; we do not see structures subject to such interpretation on specimens mounted in styrax. In spite of these differences it seems that our specimens are very probably *californica*. Length of specimen figured (No. 1939, C.A.S.

coll.) .0856 mm.; breadth .0548 mm.; (No. 1949) length .0732 mm.; breadth .0488 mm.

The original material described by Greville was reported as from "California Guano." This could hardly mean other than from some of the islands of the Gulf of California or off the west coast of Lower California.

58. *Navicula campylodiscus* Grunow

Plate 17, figures 5, 6

Navicula campylodiscus GRUNOW, SCHMIDT, Atlas Diat., pl. 70, 1881, figs. 64, 65; "Campeche Bay," Gulf of Mexico.—WOLLE, Diat. N. Am. 1894, pl. 12, fig. 15.

Our specimens are believed to be identical with this coarsely-marked form. A feature not shown by Schmidt or Wolle is the depressed central area below the level of the ends; this fortunately is well illustrated in our photograph of a specimen which became accidentally dislodged in mounting. Length of specimen figured (No. 1940, C.A.S. coll.) .0459 mm.; breadth .0285 mm.

59. *Navicula clavata* Gregory

Plate 17, figure 7

Navicula clavata GREGORY, Trans. Micr. Soc. Lond. n. s., Vol. 4, 1856, p. 46, pl. 5, fig. 17.—SCHMIDT, Atlas Diat., pl. 3, 1874, fig. 13; pl. 70, 1881, fig. 50; pl. 129, 1888, fig. 16.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 340.

Navicula hennedyi W. SMITH, VAN HEURCK, Treat. Diat. 1896, p. 204.

Navicula lyra EHRENBERG, SCHMIDT, Atlas Diat., pl. 70, 1881, fig. 47.

Dr. Mann stated in 1907 that this species stands intermediate between *N. lyra* and *N. hennedyi*. The specimens from the deposit on Maria Madre Island, as shown by the figure herewith, fully confirm this view. His specimens from near the Galapagos Islands had the space between marginal and median striations strongly granulated; ours appear to be entirely hyaline. In the deposit concerned the species is very constant in its characters, showing no tendency toward intergradation with others. Length of specimen figured (No. 1941, C.A.S. coll.) .050 mm.; breadth .0315 mm.

60. *Navicula densistriata* Schmidt

Plate 17, figures 8-10

Navicula bombus var. *densistriata* SCHMIDT, Atlas Diat., pl. 13, 1875, figs. 11, 12; "California."

Specimens from the Maria Madre Island deposit are very similar to the figures cited above which were drawn from diatoms, presumably from the Monterey Shale some place in California. If the bars with cross lines represented in the figures may be interpreted to be beads the identity is assured and this seems to be a justifiable assumption because we have numerous specimens from various Monterey Shale localities and all are beaded. It does not seem that there is certain intergradation of these fossils with *N. bombus* Ehrenberg and the form appears to be entitled to specific rank.

Specimen Number	<i>Measurements</i>	
	Length	Breadth
1942	.0820 mm.	.0364 mm.
Not figured	.0660 mm.	.0278 mm.
1943	.090 mm.	.0348 mm.
1944	.0688 mm.	.0288 mm.

61. *Navicula eastwoodi* Hanna & Grant, new species

Plate 17, figure 11

Valve lanceolate, attenuate at the ends, very convex; raphe narrow and straight with slight flexure at each end; surface marked with transverse rows of small beads, not arranged in longitudinal or diagonal rows; central nodule very small, circular, the valve not uniformly convex but with a median area higher than the sides, this area being widest at each end. Length of type .1082 mm.; width .0326 mm.

Type: No. 1945, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

No species of *Navicula* close to this has been found after an extensive search of the literature. Unfortunately the only complete valve found was slightly broken, but it hardly detracts from the remarkable beauty of the specimen.

The species is named for Miss Alice Eastwood, Curator of Botany of the California Academy of Sciences, in recognition of much assistance rendered in securing necessary literature of Diatomaceæ.

62. *Navicula hennedyi* W. Smith

Plate 18, figure 1

Navicula hennedyi W. SMITH, Syn. Brit. Diat., Vol. 2, 1853, p. 93.—SCHMIDT, Atlas Diat., pl. 3, 1874, figs. 17, 18.—WOLLE, Diat. N. Am. 1894, pl. 14, fig. 30.—VAN HEURCK, Treat. Diat. 1896, p. 204, pl. 4, fig. 160, pl. 27, fig. 755.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 345.

The Maria Madre Island fossils agree almost exactly with Schmidt's fig. 17 (Wolle's fig. 30) cited above. Schmidt called his fig. 17 "*Var. manca*" and fig. 18 "typical," but the differences seem insufficient for segregation. If, however, they should be, ours would take the name *manca*. Length of specimen figured (No. 1950, C.A.S. coll.) .100 mm.; breadth .0468 mm.

63. *Navicula impressa* Grunow

Plate 18, figure 2

Navicula impressa GRUNOW in SCHMIDT, Atlas Diat. pl. 6, 1875, figs. 17, 18, 35, 36, 39.—CLEVE, Sv. Vet. Akad. Handl., Vol. 26, 1894, p. 50.—WOLLE, Diat. N. Am. 1894, pl. 14, figs. 25, 26.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, p. 345.

The specimens from the Maria Madre Island deposit agree so well with those in the Atlas, cited above, that no adequate basis for separation can be found. The name *impressa* was originally intended to cover the coarsely-beaded forms (figs. 17, 18), which ours resemble closest, because Schmidt called figs. 35, 36, 39 a "n. sp." Dr. Mann stated, however, that the differences in the figures were not sufficient to admit maintaining two species. Length of specimen figured (No. 1946, C.A.S. coll.) .0888 mm.; width .060 mm.; number of transverse rows of beads in .01 mm. in center of valve 7.

64. *Navicula longa* (Gregory)

Plate 18, figures 3, 4

Pinnularia longa GREGORY, Trans. Mic. Sci. London, Vol. 4, 1856, p. 47, pl. 5, fig. 18.

Navicula longa (GREGORY), DONKIN, British Diatoms, 1871-72, p. 55, pl. 8, 3a, 3b.—SCHMIDT, Atlas Diat., pl. 47, 1876, figs. 8-10.—WOLLE, Diat. N. Am. 1894, pl. 12, fig. 23.

Navicula directa W. SMITH, CLEVE, Kongl. Sv. Vet. Akad. Hand., Vol. 27, No. 3, 1895, p. 27.

Individuals of this coarsely-marked species are common in the Maria Madre Island deposit. The number of short transverse ribs at the stauros varies from two to four. Cleve placed this form under *N. directa* questionably and stated that he had not seen such a diatom as Gregory figured with radial striæ. Length of specimen figured (No. 1951, C.A.S. coll.) .1018 mm.; width .0178 mm.

65. *Navicula lyra* Ehrenberg

Plate 18, figure 5

Numerous specimens of this protean and widely distributed species occur in the Maria Madre Island deposit. The range of variation is much more circumscribed in the series studied than is the rule among living specimens. The specimen figured is representative of the series and corresponds very closely with what Schmidt called "subtypical."³⁷ Numerous variations have been named, based on differences of shape and sculpture, but it appears that our specimens may remain satisfactorily under the species name.³⁸ Length of specimen figured (No. 1952, C.A.S. coll.) .1170 mm.; width .040 mm.

66. *Navicula madræ* Hanna & Grant, new species

Plate 18, figure 6

Valve elongate, indented on the sides with a gentle concave curve; roundly pointed terminally; heavily marked throughout; raphe spindle shaped, rounded at both ends and with a row of 15 beads on each side; margins with 35 heavy costæ,

³⁷ Schmidt, Atlas Diat., pl. 2, fig. 25, 1874.

³⁸ See in this connection, Mann. Cont. Nat. Herb., Vol. 10, pt. 5, 1907, pp. 347-348.

each terminating inwardly in a knob; each rib is marked with a double row of faint beads. Length .080 mm.; width .0270 mm.

Type: No. 1953, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species is similar to the one figured by Schmidt from the Moron Deposit of Spain³⁹; that form, however, has a greater number of beads along the raphe, more ribs along the margins and more secondary beads on each rib. The Maria Madre species is common in the deposit and does not agree in detail with several allied forms from the Monterey Shale of California, such as *N. vagabunda* Brun, *N. sideralis* Brun, etc.

67. *Navicula ortolanæ* Hanna & Grant, new species

Plate 18, figure 7

Valve broadly oblong, rounded on the ends, sides almost straight; raphe narrow and straight; central nodule circular; surface marked with slightly radiating lines of beads, those nearest the margin being largest; in the center of the valve the dots are also so arranged as to make arcs of circles, the convex sides outermost; the valve is decidedly convex but unevenly so. Length .0743 mm.; width .0379 mm.

Type: No. 1954, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

A search of the literature has failed to disclose any species comparable to this. It is very rare, and long search failed to disclose a more perfect specimen than the figured type, but it is believed to be worth describing since all the essential characters are preserved.

³⁹ Schmidt, Atlas Diat., pl. 70, 1881, fig. 74; Fricke, in the index to the Atlas, 1902, stated that this Moron diatom was *Navicula gemmata fossilis* Pantocsek.

68. *Navicula pandura* Brebisson

Plate 18, figure 8

Navicula pandura BREBISSON, SCHMIDT, Atlas, pl. 11, 1875, figs. 1, 2, 4, 8, 9.

Coarsely-marked diatoms with double rows of minute beads on the costæ are common in the Maria Madre Island deposit. They agree in shape and sculpture with the figures cited, but it must be said that some uncertainty attends the identification of any diatom belonging to this group. Cleve⁴⁰ was not able to make satisfactory distinctions and united a great many names, including *pandura*, as "varieties" under *N. crabro*. Length of specimen figured (No. 1948, C.A.S. coll.) .1280 mm.; width .040 mm.

69. *Navicula pelagi* Schmidt

Plate 18, figure 9

Navicula pelagi SCHMIDT, Atlas Diat., pl. 7, 1875, figs. 25, 26.
D. (iploneis) fusca var. *pelagi* A. S., CLEVE, Kongl. Sv. Vet. Akad. Hand., Vol. 26, No. 2, 1894, p. 93.

Specimens which agree almost exactly with the original figures of this species from Campeche Bay, Gulf of Mexico, are common in the Maria Madre Island fossil deposit. They show no indication of intergradation with *N. smithii* in the same deposit.

70. *Navicula prætexta* Ehrenberg

Plate 18, figures 10-12

Navicula prætexta EHRENBURG, Ber. Akad. Wiss. Berl. 1840 (1841), p. 214.—EHRENBURG, Microgeologie, 1854, pl. 19, fig. 28.—SCHMIDT, Atlas Diat., pl. 3, 1874, figs. 30-34; pl. 129, 1888, figs. 7-8.—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 352.

This beautiful diatom is one of the most common of the naviculoid forms in the Maria Madre Island deposit. Cleve recognized two fossil subspecies, *abundans* Schmidt⁴¹ from

⁴⁰ Kongl. Sv. Vet. Akad. Handl., Vol. 26, 1894, p. 100.

⁴¹ Atlas Diat., pl. 129, 1888, fig. 8.

Monterey and Santa Monica, California, fossil deposits, and *haytiana* Truan & Witt, from Hayti. The value of these names seems problematic.

Specimen number	Measurements	
	Length	Width
1956	.0910 mm.	.0584 mm.
1957	.0910 mm.	.0496 mm.
1958	.0886 mm.	.0550 mm.

71. *Navicula regata* Hanna & Grant, new species

Plate 18, figure 13

Valve small, slightly constricted in the middle, roundly pointed at each end; marked with a double row of transversely elongated beads or bars on each side of the median area, the latter with a faint row of dots on each side of the raphe which is not placed on a heavy bar of silica. Length .0418 mm.; width .020 mm.

Type: No. 1959, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This minute species seems to be closest to one from Campeche Bay, Gulf of Mexico, figured by Schmidt⁴² and questionably referred to *N. donkini* Schmidt. But the latter and all other constricted diatoms of this section of *Navicula* appear to have the raphe placed on a heavy rounded bar of silica; details of markings are likewise very different in the new species.

72. *Navicula smithii* Brebisson

Plate 19, figure 1

Navicula smithii BREBISSEON in W. SMITH, Brit. Diat., Vol. 2, 1856, p. 92.—SCHMIDT, Atlas Diat., pl. 7, 1875, fig. 19.—CLEVE, Kongl. Sv. Vet. Akad. Handl., Vol. 26, No. 2, 1894, p. 96.

Schmidt said that his figure, cited above, was a typical valve of the highly variable *N. smithii* and our Maria Madre Island fossils are closer to it than any other we have found. The

⁴² Atlas Diat., pl. 12, 1875, fig. 63.

identification is, therefore, reasonably certain to be correct. Length of specimen figured (No. 1960, C.A.S. coll.) .090 mm.; width .0476 mm.

73. *Navicula spectabilis* Gregory

Plate 19, figure 2

Navicula spectabilis GREGORY, Trans. Royl. Soc. Edinb., Vol. 21, 1857, p. 481, pl. 9, fig. 10.—SCHMIDT, Atlas Diat., pl. 2, 1874, fig. 31, pl. 3, figs. 20-21, 29.—VAN HEURCK, Treat. Diat. 1896, p. 202, pl. 27, fig. 757.—WOLLE, Diat. N. Am. 1894, pl. 16, fig. 3 (very poor).—MANN, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 356.

This species approaches both *N. lyra* and *N. hemedyi*, the Maria Madre Island fossils agreeing almost exactly with Schmidt's fig. 20, pl. 3, cited above. Length of specimen figured (No. 1961, C.A.S. coll.) .0636 mm.; width .0384 mm.

74. *Navicula splendida* Gregory

Plate 19, figure 4

Navicula splendida GREGORY, Trans. Micr. Soc. London, Vol. 4, p. 44, pl. 5, fig. 14.—VAN HEURCK, Syn. Diat. Belg., pl. 9, fig. 4.—SCHMIDT, Atlas Diat., pl. 13, 1875, figs. 31-34.

Like *N. pandura*, there are a great many coarsely-marked, constricted diatoms in the Maria Madre Island deposit which have the costæ divided into single beads by longitudinal furrows. Many variations have been named which have this general form of sculpture, but it appears that for the present it would be best to follow Cleve⁴³ as nearly as possible and group them under *N. splendida*. Length of specimen figured (No. 1948a, C.A.S. coll.) .1216 mm.; width .0334 mm.

75. *Navicula stippi* Hanna & Grant, new species

Plate 17, figure 12

Valve ovate, flat, almost twice as long as broad; raphe straight, narrow, bordered on each side almost to the central nodule by a band of fine transverse striæ; margin bounded by a narrow zone of fine radial striæ of uniform length; remain-

⁴³ Naviculoid Diatoms, Kongl. Sv. Vet. Akad. Handl., Vol. 26, 1894, pp. 85-86.

der of disk sparsely covered with beads irregularly arranged except for a short space near the center of each side where they seem to be in short radial rows. Length .0859 mm.; width .0474 mm.; width of zone of striæ bordering raphe .0038 mm.; width of zone of striæ at margin and in the center of the valve .0034 mm.

Type: No. 1947, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This delicate species partakes of the characters of *N. californica* in shape and arrangement of border and raphe zones but the striæ are very much finer, in fact an oil immersion lens is required to resolve them into beads. It also has scattered beads over the disk somewhat as in *N. prætecta* but is likewise much more delicate than that species.

The species is named for Mr. Thomas F. Stipp of San Francisco, California, in recognition of his interest in microscopy.

76. *Navicula subspectabilis* Hanna & Grant, new species

Plate 19, figure 3

Valve broadly ovate, rounded at the ends, similar to *N. spectabilis*; zone of beading at the margin with only 50 transverse rows of beads (*spectabilis* has 70 to 80 rows); large lyri-form blank space, unmarked, broad, and with only a faint indication of projections medially of the marginal beaded zones. Length .0445 mm.; width .0267 mm.

Type: No. 1962, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

We regret the necessity of adding a new name to the overburdened group of which *N. spectabilis* is a member, but we have been unable to find a figure or description which appears to be sufficiently close to these small specimens to include them. Besides the small size, the sparseness of the bead-rows is the chief distinguishing feature.

77. *Navicula vidovichii* Grunow

Plate 19, figure 5

Navicula vidovichii GRUNOW, Verh. K. K. Zool. Bot. Ges. Wein 1863, p. 150, pl. 4 (13), fig. 4; Adriatic Sea.

Caloneis powellii vidovichii (GRUNOW), CLEVE Kongl. Sv. Vet. Akad. Handl., Vol. 26, No. 2, 1894, p. 63.

Ostrupia powellii vidovichii (GRUNOW), SCHMIDT, Atlas Diat., pl. 264, 1906, figs. 8, 9; "Hafen von Pola (Adria)."

Our specimen, which agrees in minute detail with the original figure of Grunow as well as the one in Schmidt's Atlas, was picked out of the Maria Madre Island deposit and others were seen. It would seem to have very little in common with *N. powellii* Lewis,⁴⁴ although Cleve united it subspecifically. Likewise, there appears to us to be no substantial reason for placing the species in a new genus as Heiden has done in Schmidt's Atlas. It is a striking species of *Navicula* but does not seem to differ basically from many others of that genus. Length of specimen figured (No. 1963, C.A.S. coll.) .1140 mm.; width .0190 mm.

78. *Nitzschia hondoensis* Hanna & Grant, new species

Plate 21, figure 5

Valve slightly sigmoid in outline; with a longitudinal row of heavy quadrangular beads near but not adjacent to the superior margin; surface otherwise covered with minute dots in transverse rows and at the same time in irregular, diagonal rows toward the inferior margin. Length .1522 mm.; width .010 mm.

Type: No. 1964, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The species belongs to a group of which *N. sigma* Smith is the most familiar,⁴⁵ but the Maria Madre Island fossil is broader, and the row of coarse beading is set away from the margin a perceptible distance, not adjacent to the margin as in

⁴⁴ Proc. Acad. Nat. Sci. Phila. 1861, p. 65, pl. 2, fig. 6.

⁴⁵ Schmidt, Atlas Diat., pl. 336, 1921, figs. 1-6.

N. sigma. Moreover, the beading of *N. hondoensis* forms wavy diagonal lines toward the inferior margin as well as transverse lines; *N. sigma* only has the latter.

79. *Nitzschia nelsoni* Hanna & Grant, new species

Plate 21, figures 6, 7

Valve long and slender, straight on one side, curved on the other; ends bluntly rounded; markings consisting solely of two rows of heavy, elongated bars, largest in the center of the valve and tapering gradually to each end. Length of type .1162 mm.; width .0135 mm.; length of paratype .1336 mm.; width .0127 mm.

Type: No. 1965, *paratype* No. 1966, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This diatom has excessively robust markings for a *Nitzschia* and in this respect does not resemble closely any other form known to us. It is named for Captain M. M. Nelson of the U. S. S. *Ortolan*, whose cooperation in 1925 was largely responsible for the success of the Academy's expedition to west Mexican islands.

80. *Nitzschia princeps* Hanna & Grant, new species

Plate 21, figure 8

Valve large, robust, elongated, constricted in the middle on both sides; superior margin greatly thickened and bearing about 70 large costæ; surface marked with transverse rows of minute beads, close-set except in the center of the valve where they are "patchy." Length .1384 mm.; width .0328 mm.

Type: No. 1967, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This species resembles *N. bilobata* Smith and *N. panduriformis* Gregory in general, bilobed form, but the beading on



the surface is not broken irregularly in patches in those species as in this. *N. plana* Smith⁴⁶ does have irregular beading somewhat similar to *princeps* in a general way but is entirely different in shape. The new species occurs frequently in the Maria Madre Island deposit.

81. *Orthonais splendida* (Gregory)

Plate 19, figure 6

Cocconeis splendida GREGORY, Trans. Roy. Soc. Edinburgh, Vol. 21, 1857, p. 493, pl. 9, fig. 29.—MANN, Cont. U. S. Nat. Herb., Vol. 10, pt. 5, 1907, p. 332.

Orthonais splendida VAN HEURCK, Treat. Diat. 1896, p. 283, fig. 62.

Specimens of this species from the Maria Madre Island deposit agree in minute detail with the figure of Van Heurck, cited above. The one figured (No. 1968, C.A.S. coll.) is .0468 mm. long and .0368 mm. wide.

82. *Plagiogramma fascinatum* Hanna & Grant, new species

Plate 19, figure 7

Valve regularly oval, a little more than twice as long as broad; ends rounded; terminal spaces almost circular, central area transversely oval, all hyaline; between the central area and each terminal area there are four transverse rows of huge circular beads, six in each row and close set. Length .040 mm.; width .0127 mm.

Type: No. 1969, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

In outline the species is much like *Glyphodesmis exima* Greville,⁴⁷ but the Maria Madre Island form is a true *Plagiogramma*, having a large central stauros and not merely a central nodule as in *Glyphodesmis*. No other species of *Plagiogramma* is known to us which has beads so large and heavy in proportion to the size of the valve.

⁴⁶ Schmidt, Atlas Diat., pl. 330, 1921, fig. 3.

⁴⁷ Schmidt, Atlas Diat., pl. 210, 1897, figs. 13-17.

83. *Plagiogramma hymenoptera* Hanna & Grant, new species

Plate 19, figure 8

Valve deeply constricted in the center, swollen on each side of this constriction and again between this and the ends, thus making three constrictions on each valve; central stauros broad and square with a pyriform central nodule; surface covered with rounded beads, sparsely but uniformly arranged in transverse and longitudinal rows except at the ends where the beads are still sparse but irregularly arranged; a spatula-shaped projection at each end, in place of a spine or stauros. Length .1009 mm.; width .0162 mm.

Type: No. 1970, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Schmidt⁴⁸ has figured some specimens from Macassar Strait which resemble the present species in general form; he referred these questionably to *P. constrictum* Greville, a heavily-ribbed species which they hardly resemble at all; our specimens have a larger stauros than those of Schmidt, which also lack the spatula-shaped terminal stauros.

84. *Plagiogramma insolito* Hanna & Grant, new species

Plate 19, figure 9

Valve small, broad, sides straight, ends pointed; central area oval, terminal areas pointed; no internal septæ; beads roundly rectangular, in horizontal and longitudinal rows; terminal areas marked with fine radial striations. Length of type .0675 mm.; width .020 mm.

Type: No. 1971, *paratype* No. 1972, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This heavily-marked species appears to have no close relative except *P. tessellatum*, a comparison with which shows the distinction at once.

⁴⁸ Atlas Diat., pl. 210, 1897, figs. 28-30.

85. *Plagiogramma tessellatum* Greville

Plate 19, figure 10

Plagiogramma tessellatum GREVILLE, Quart. Journ. Mic. Sci., Vol. 7, 1859, p. 208, pl. 10, fig. 7.—WOLLE, Diat. N. Am. 1894, pl. 45, figs. 18, 19.—SCHMIDT, Atlas Diat., pl. 209, 1897, figs. 42-50.

Except for the slight constriction medially (and this is not constant), the fossils referred to this species are typical *tessellatum* as figured by Schmidt (fig. 48). It is the most common form of the genus in the deposit on Maria Madre Island and, from the published records, seems to be almost wholly confined to the east coast of North America, and especially the Caribbean region. Dr. Mann,⁴⁹ however, lists it from the Galapagos Islands, although he stated that the central area was round in the specimens instead of rectangular as usual. In our specimens the area is rectangular as are, likewise, the coarse beads. Length of specimen figured (No. 1973, C.A.S. coll.) .1160 mm.; width .0180 mm.

86. *Pleurosigma manni* Hanna & Grant, new species

Plate 19, figure 11; plate 20, figure 1

Valve narrowly lanceolate, not sigmoid, very thin and delicate; raphe almost straight; rows of beads in two series set at about 120° to each other; dots heavy, easily seen with an eight millimeter apochromatic objective and 15x ocular. Length .2272 mm.; width .0454.

Type: No. 1974, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

A few other straight diatoms belonging to *Pleurosigma* are known, but apparently none combines the characters of this one. Although fragments are very abundant in the Maria Madre Island deposit, this diatom is so excessively delicate that it is almost impossible to secure perfect examples. Some have even been deformed by pressure in the bedded material.

The species is named for the distinguished diatomist, Dr. Albert Mann of Washington, D. C.

⁴⁹ Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 326.

87. *Podosira adriatica* (Kützing)

Plate 20, figure 2

Specimens which agree with Van Heurck's⁵⁰ figure of this species are not rare in the Maria Madre Island deposit. The California fossil, *P. febigerii* Grunow, is similar in structure but appears from the figures to be more heavily marked and uniformly convex. Diameter of specimen figured (No. 1975, C.A.S. coll.) .060 mm.

88. *Podosira clarki* Hanna & Grant, new species

Plate 20, figure 3

Valve minute, strongly convex; border wide and radiately striated; surface except central zone marked by numerous elevated protuberances; also a series of minute beads uniformly dispersed in a series of imperfectly radiating sectors; these beads also have an imperfect "watch case milling" arrangement; central rosette small but distinct. Diameter .0360 mm.

Type: No. 1976, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This minute species is so distinct from other *Podosira* with its many large protuberances that comparison can hardly be made with any. A lens with high numerical aperture is necessary properly to resolve the beautiful markings.

The species is named for Dr. Bruce L. Clark, Professor of Paleontology, University of California, who has often aided in work with the diatomaceæ of California.

89. *Podosira ovoidea* Hanna & Grant, new species

Plate 20, figure 4

Valve oval very convex, apparently hyaline throughout; central area less elongate ovate than the valve and bordered by a single row of long, sharp spines; margin narrow and crenulated. Length .0247 mm.; width .0171 mm.

⁵⁰ Treat. Diat., 1896, p. 447, fig. 171.

Type: No. 1977, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

So far as we can determine no ovate *Podosira* has heretofore been described, yet in the absence of characters which would ally this little diatom with any other genus, we prefer to leave it here for the present. Possibly it belongs to a group which has not been generically segregated, yet warrants such disposition. Specimens of the species are rare in the deposit.

90. *Podosira polita* Hanna & Grant, new species

Plate 20, figure 5

Valve circular, convex, densely covered with minute beading except for a ragged, rugose, area in the center; the beads have an imperfect watch case milled arrangement and are in radial rows which form distinct zones, the rows of each zone set at an acute angle to those adjacent. Diameter .0362 mm.

Type: No. 1978, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This beautiful species seems to be related to *P. subtilis* (Bailey) but has much coarser beading than that species. Moreover, *subtilis* has a perfect watch case milled arrangement of beads, this has not.

91. *Porpeia quadriceps* Bailey

Plate 20, figures 6, 7

Individuals of this protean species are common in the Maria Madre Island deposit. Several variations have received names such as *quadrata*, *ornata*, *robusta*, and *inflexa*, but, as Mann⁵¹ has pointed out, they have little to distinguish them and may best all be united under the earliest name, *quadriceps*. Dr. Mann also gave numerous references to the literature where

⁵¹ Cont. U. S. Nat. Herb., Vol. 10, pt. 5, 1907, p. 315.

figures of the various forms may be found. The specimens figured herewith are mounted on one slide, No. 1979, C.A.S. coll.; height in side view .0256 mm.; length in end view .070 mm.; width in end view .0169 mm.

92. *Rhaphoneis ampiceros* Ehrenberg

Plate 20, figure 8

Rhaphoneis ampiceros EHRENBURG, SCHMIDT, Atlas Diat., pl. 269, 1911, figs. 45, 46, 50-55.—WOLLE, Diat. N. Am. 1894, pl. 37, figs. 18-22.

Typical specimens of this variable species are not uncommon in the Maria Madre Island deposit. Length of specimen figured (No. 1980, C.A.S. coll.) .050 mm.; width .0248 mm.

93. *Rhaphoneis cocconeiformis* (Schmidt)

Plate 20, figure 9

Coscinodiscus cocconeiformis SCHMIDT, Atlas Diat., pl. 58, 1877, figs. 23, 28; Monterey [California, type locality, probably Miocene deposit].

Our specimens from the Maria Madre Island Miocene deposit are identical with the figures Schmidt drew from specimens from "Monterey." These are circular forms with markings precisely as in *Rhaphoneis* and wholly unlike any other *Coscinodiscus*; therefore it seems inconsistent to retain them in the latter genus. The total absence of raphe or pseudo-raphe definitely excludes them from *Cocconeis*. Diameter of specimen figured (No. 1981, C.A.S. coll.) .0730 mm.

94. *Rhabdonema adriaticum* Kützing

Rhabdonema adriaticum KÜTZING, Bacill. 1844, p. 127, pl. 18, fig. 7.—SCHMIDT, Atlas Diat., pl. 217, 1899, figs. 17-29; pl. 221, 1900, fig. 14.—MANN, Cont. U. S. Nat. Herb., Vol. 10, pt. 5, 1907, p. 321.

A single group of valves firmly attached was found in the Maria Madre Island deposit. In side view, all that can be seen, the specimen resembles the figures of *adriaticum* more than any other species.

95. *Stephanogonia pretiosa* Hanna & Grant, new species

Plate 20, figure 10

Valve circular, pyramidal with 11 slightly unequal and unmarked facets; top truncate and this portion with a very few irregularly scattered dots of minute size; the flat angular faces bordering the central area are separated by heavy bars of silica. Diameter .0214 mm.

Type: No. 1982, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Van Heurck⁵² stated that the genus *Stephanogonia* comprised a very few species, all fossil. We have examined figures of apparently all that have been described but find nothing very closely approaching the form here treated. It is possibly closest to *S. actinoptychus* Ehrenberg as figured by Van Heurck,⁵³ but that species is ovate in shape and heavily spinose around the margin; moreover it is punctate throughout the valval area.

96. *Stephanopyxis corona* (Ehrenberg)

Plate 20, figure 11

Systephania corona EHRENBERG, Ber. Akad. Wiss. Berl. 1844, p. 272.—

EHRENBERG, Microg., pl. 33, group 15, fig. 22.

Stephanopyxis corona (EHRENBERG), GRUNOW in VAN HEURCK, Syn.

Diat. Belg., pl. 83 ter., figs. 10, 17, 1881.—SCHMIDT, Atlas Diat.,

pl. 123, 1888, figs. 10-17, 19, 20; pl. 130, 1888, figs. 13, 16, 17, 36.—

WOLLE, Diat. N. Am. 1893, pl. 62, figs. 1, 6; pl. 67, fig. 20.

A very few specimens which seem to be referable to the above species were found in the fossil material from Maria Madre Island. The one figured, No. 1983 (C.A.S. coll), is .0565 mm. in diameter.

⁵² Treat. Diat., 1896, p. 437.

⁵³ Ibid., fig. 163.

97. *Stictodiscus californicus* Greville

Plate 20, figure 12

Stictodiscus californicus GREVILLE, Trans. Micr. Soc. London, n. s., Vol. 9, 1861, p. 79, pl. 10, fig. 1.—SCHMIDT, Atlas Diat., pl. 74, 1882, figs. 4, 5.—WOLLE, Diat. N. Am. 1894, pl. 75, figs. 5-8 (not well drawn).

This common west American species, first described from the Miocene Monterey Shale, is also common in the deposit on Maria Madre Island. It has not, apparently, been found living on the west coast, but has been considered to be one of the best markers of the widespread Miocene diatomaceous shale. Diameter of specimen figured (No. 1984, C.A.S. coll.) .0908 mm.

98. *Surirella newmani* Hanna & Grant, new species

Plate 21, figure 1

Valve ovate, narrowly rounded on the ends with a narrow lanceolate median hyaline area bordered by 10 heavy, radiating, flat-topped ribs; each of these in the median section bears two or three bars parallel to the rib; border undulating, very heavy and with some transverse striations; with a lens of 2 mm. equivalent focus and N. A. 1.32 it was barely possible to resolve the beads on the bars mentioned. Length .060 mm.; width .030 mm.

Type: No. 1985, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

This species comes close to an unnamed figure of Schmidt⁵⁴ from Campeche Bay, Gulf of Mexico, and which Fricke⁵⁵ stated was a doubtful "variety" of *S. comis* Schmidt. We cannot agree to that identification and, even if correct, our specimens differ sufficiently to be recorded as distinct. It is not uncommon in the deposit on Maria Madre Island.

The species is named for Mr. P. E. Newman, a microscopist of great skill of San Francisco, California.

⁵⁴ Atlas Diat., pl. 4, 1874, fig. 7.

⁵⁵ Index to Atlas, 1902, p. 61.

99. *Surirella patens* Schmidt

Plate 21, figure 2

Surirella patens SCHMIDT, Atlas Diat., pl. 4, 1874, figs. 16, 17; "Carpenteria Bai."

Specimens which agree essentially with those of Schmidt are common in the Miocene deposit on Maria Madre Island. The central hyaline space in his figures is bordered on each side with a longitudinal row of dots which extend from end to end; in our specimens these rows are not continuous, there being a blank space in the center. This would hardly seem sufficient difference to warrant specific separation. Each of the large transverse bars of silica has three rows of minute beads, which, except under proper magnification and illumination, appear as striæ. Our photograph shows the true character of these markings. Length of specimen figured (No. 1986, C.A.S. coll.) .0946 mm.; width .0375 mm.

100. *Synedra duhemi* Hanna & Grant, new species

Plate 21, figure 3

Valve long and slender, subrostrate truncate at the ends; very convex, the cross section being as shown at *a* in figure 3; longitudinally the valve is also very convex in the center; markings consist of heavy transverse rows of beads which leave a narrow longitudinal hyaline line through the center; this line, however, does not reach to the ends of the valve but tapers out to nothing at about .01 mm. from the ends; the rows of beads are not uniformly placed as in *S. ulna* (Nitzsch) but they often bifurcate. Length .2236 mm.; width .01492 mm.; number of rows of beads in .01 mm. at center of valve, 8.

Type: No. 1987, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

The great convexity of the valve in cross and longitudinal sections and the coarse, close-set lines of beads separate this

species from any other known to us. Its outline is similar to *S. ulna*, but that species is almost flat, has fine rows of dots and usually a stauros in the center.

The species is named for Mr. Raymond Duhem, the photographer of the Academy's expedition to West Mexican islands in 1925.

101. *Trachyneis aspera* (Ehrenberg)

Plate 21, figure 4

Navicula aspera (EHRENBERG), SCHMIDT, Atlas Diat., pl. 48, 1876, figs. 2-6.

Individuals which we have referred to this species occur frequently in the Maria Madre Island deposit; they show some variation in the size of the valves but in details of markings they are very close to those Schmidt figured. Many diatomists have placed this distinctive group in *Navicula*.⁵⁶ Cleve⁵⁷ separated it under *Trachyneis*, and Van Heurck in 1896⁵⁸ recognized its distinctness but kept the species, which he treated, under *Navicula* in order to conform with a previous publication. It would seem to us that the group is sufficiently distinct to be separated in almost if not all cases. Length of specimen figured (No. 1988, C.A.S. coll.) .0878 mm.; width .0276 mm.

102. *Xanthiopyxis cingulata* Ehrenberg

Plate 21, figure 9

Xanthiopyxis cingulata EHRENBERG, Microgeologie, 1854, pl. 33, group 17, fig. 18; Rappahannock, Virginia.

This species is circular and has spines uniformly distributed over the disk and projecting outwardly from the margin. The species occurs abundantly in Maria Madre Island deposit. The

⁵⁶ See Mann, Cont. U. S. Nat. Herb., Vol. 10, No. 5, 1907, p. 337.

⁵⁷ Sv. Vet. Akad. Hand., Vol. 26, 1894, p. 191, pl. 3, fig. 37.

⁵⁸ Treat. Diat., 1896, p. 205.

common species of the genus in the Monterey Shale of California, *X. umbonata* Greville, lacks the marginal spines. Van Heurck⁵⁹ stated that the genus contains 12 "curious species," all fossil. It was at one time believed by some diatomists that members of the group were sporangial cases of species belonging to the genus *Chatoceros*, but if that be admitted it is difficult to explain the great abundance of *Xanthiopyxis* in some deposits where a trace of *Chatoceros* cannot be found. Our experience in dealing with fossil forms leads us to believe that *Xanthiopyxis* is probably a valid generic assemblage of species. Diameter of specimen figured (No. 1989, C.A.S. coll.) is .0418 mm.

103. *Xanthiopyxis hirsuta* Hanna & Grant, new species

Plate 21, figure 10

Valve broadly ovate, convex, border narrow; densely covered with a series of short, sharp spines; spines even cover the border and project outwardly therefrom; with dry lenses the surface has an irregularly stippled effect, but with the greater numerical aperture of immersion objectives the dots are resolved into spines. Length .0298 mm.; width .020 mm.

Type: No. 1990, Mus. Calif. Acad. Sci., from **Arroyo Hondo, Maria Madre Island (Tres Marias Group), Mexico**; collected by Hanna & Jordan, May, 1925; Miocene.

Some difficulty was experienced in the assignment of this species to a suitable genus and even now we are somewhat undecided if it should be placed in *Xanthiopyxis*. Certainly all other members of that group with which we are familiar have much heavier and fewer spines than this one. The species is very common in the deposit on Maria Madre Island.

104. *Xanthiopyxis oblonga* Ehrenberg

Plate 21, figure 11

Xanthiopyxis oblonga EHRENBURG, *Microgeologie*, 1854, pl. 33, group 17, fig. 17.; Rappahannock, Virginia.—CLEVE, *Journ. Quek. Micr. Club*, ser. 2, Vol. 2, 1885, p. 175, pl. 13, fig. 18; Brun Tegel (Marl) Moravia.

⁵⁹ *Treat. Diat.*, 1896, p. 512.

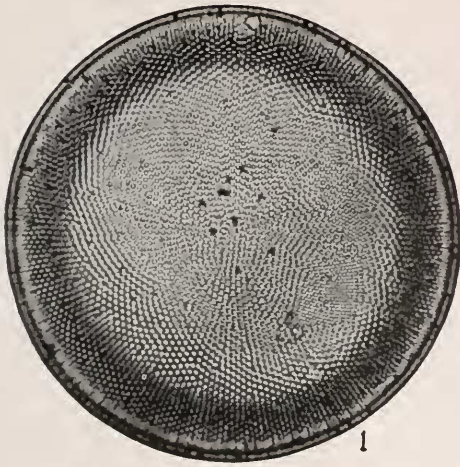
Cleve remarked that there was a possibility of this being an auxospore stage of some diatom like *Hemialus*, but, in view of the great abundance of it in the Maria Madre Island deposit and the rarity of *Hemialus*, this interpretation seems doubtful. Cleve also stated that the species was closely related to *Stephanopyxis limbata* Ehrenberg.⁶⁰ The specimen figured (No. 1991, C.A.S. Coll.) is .035 mm. long, .0183 mm. wide, exclusive of spines and in no important manner seems to differ from the figures cited above.

⁶⁰ Van Heurck, Syn. Diat. Belg., 1880-1885, pl. 83, ter. figs. 13-14.

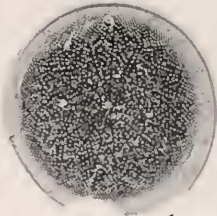
PLATE 11

- Fig. 1. *Actinocyclus allinarius* H. & G., n. sp. x 380.⁶¹ Type, No. 1871, C.A.S. coll. P. 117.
- Fig. 2. *Actinocyclus canestrus* H. & G., n. sp. x 400. Type, No. 1872, C.A.S. coll. P. 117.
- Fig. 3. *Actinocyclus cubitus* H. & G., n. sp. x 1200. Type, No. 1873, C.A.S. coll. P. 118.
- Fig. 4. *Actinocyclus pyrotechnicus* Deby. x 450. Plesiotype, No. 1874, C.A.S. coll. P. 119.
- Fig. 5. *Actinocyclus rosolco* H. & G., n. sp. x 400. Type, No. 1875, C.A.S. coll. P. 119.
- Fig. 6. *Actinoptychus gallegosi* H. & G., n. sp. x 540. Type, No. 1876, C.A.S. coll. P. 120.
- Fig. 7. *Actinoptychus glabratus* Grunow. Plesiotype, No. 1877, C.A.S. Coll. P. 121.
- Fig. 8. *Actinoptychus maculatus* Grove & Sturt. x 1200. Plesiotype, No. 1878, C.A.S. coll. P. 122.
- Fig. 9. *Actinoptychus maculatus*, G. & S. Diagram of same specimen as fig. 8, to show maculations when the diatom is in a slightly different focus. P. 122.
- Fig. 10. *Actinoptychus perplexus* H. & G., n. sp. x 840. Type, No. 1879, C.A.S. coll. P. 122.
- Fig. 11. *Actinoptychus perplexus*. Portion of same specimen as fig. 10 enlarged x 1600 to show details of sculpture. P. 122.

⁶¹The magnifications indicated in the explanations of the plates are only approximately correct due to certain processes of lithography; the reader is referred to the descriptions for actual dimensions of the objects.



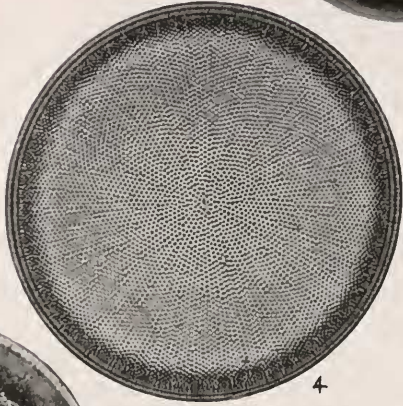
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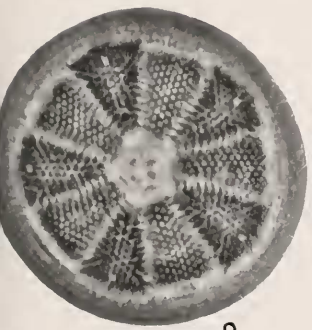


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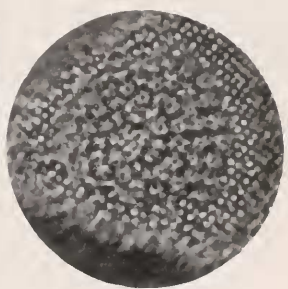
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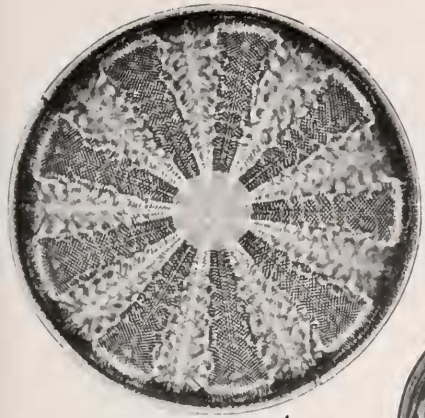
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PLATE 12

- Fig. 1. *Actinoptychus solisi* H. & G., n. sp. x 420. Type, No. 1880, C.A.S. coll. P. 123.
- Fig. 2. *Actinoptychus solisi* H. & G., n. sp. x 570. Paratype, No. 1881, C.A.S. coll. P. 123.
- Fig. 3. *Actinoptychus solisi* H. & G., n. sp. x 380. Paratype, No. 1882, C.A.S. coll. P. 123.
- Fig. 4. *Actinoptychus undulatus* (Bailey.) x 960. Plesiotype, No. 1883, C.A.S. coll. P. 124.
- Fig. 5. *Amphora crassa* Gregory. x 630. Plesiotype, No. 1884, C.A.S. coll. P. 124.
- Fig. 6. *Amphora varia* H. & G., n. sp. x 600. Type, No. 1885, C.A.S. coll. P. 124.
- Fig. 7. *Arachnoidiscus monni* H. & G., n. sp. x 315. Type, No. 1886, C.A.S. coll. P. 125.
- Fig. 8. *Arachnoidiscus manni* H. & G., n. sp. x 300. Paratype, No. 1887, C.A.S. coll. P. 125.
- Fig. 9. *Arachnoidiscus manni* H. & G., n. sp. x 600. Paratype, No. 1888, C.A.S. coll. P. 125.



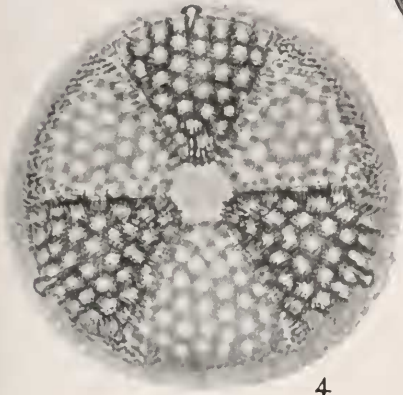
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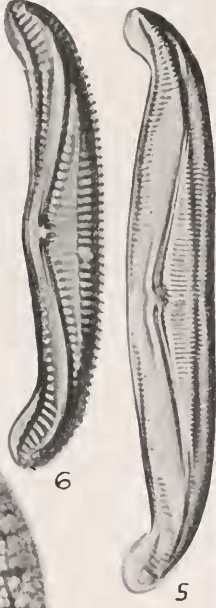
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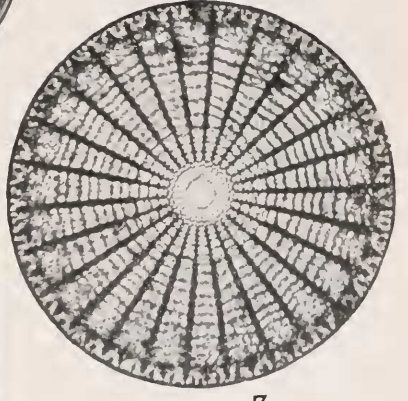


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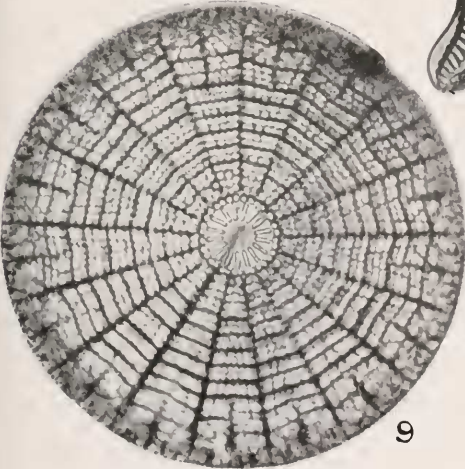


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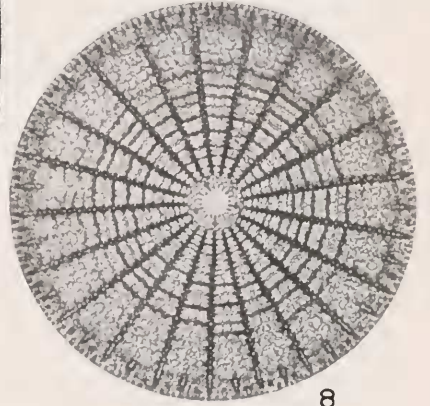
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PLATE 13

- Fig. 1. *Astrolampra marylandica* Ehrenberg, x 540. Plesiotype, No. 1889, C.A.S. coll. P. 126.
- Fig. 2. *Aterompholus dubius* H. & G., n. sp., x 800. Type, No. 1890, C.A.S. coll. P. 126.
- Fig. 3. *Aulacodiscus margaritaccus* Ralfs. x 400. Plesiotype, No. 1891, C.A.S. coll. P. 127.
- Fig. 4. *Aulacodiscus margaritaccus* Ralfs. x 300. Plesiotype, No. 1892, C.A.S. coll. P. 127.
- Fig. 5. *Aulacodiscus rella* H. & G., n. sp. x 720. Type, No. 1893, C.A.S. coll. P. 128.
- Fig. 6. *Aulacodiscus rella* H. & G., n. sp. x 800. Same specimen as fig. 5 but under slightly altered focus to show secondary markings.
- Fig. 7. *Auliscus caballi* Schmidt. x 1000. Plesiotype, No. 1894, C.A.S. coll. P. 129.
- Fig. 8. *Auliscus calatus* Bailey. x 480. Plesiotype, No. 1895, C.A.S. coll. P. 129.
- Fig. 9. *Auliscus grunovii* Schmidt. x 600. Plesiotype, No. 1896, C.A.S. coll. P. 129.
- Fig. 10. *Auliscus pruinosus* Bailey. x 540. Plesiotype, No. 1897, C.A.S. coll. P. 130.
- Fig. 11. *Biddulphia consimile* Grunow. x 300. Plesiotype, No. 1899, C.A.S. coll. P. 130.
- Fig. 12. *Biddulphia consimile* Grunow. x 800. Same specimen as fig. 11, enlarged to show secondary markings.

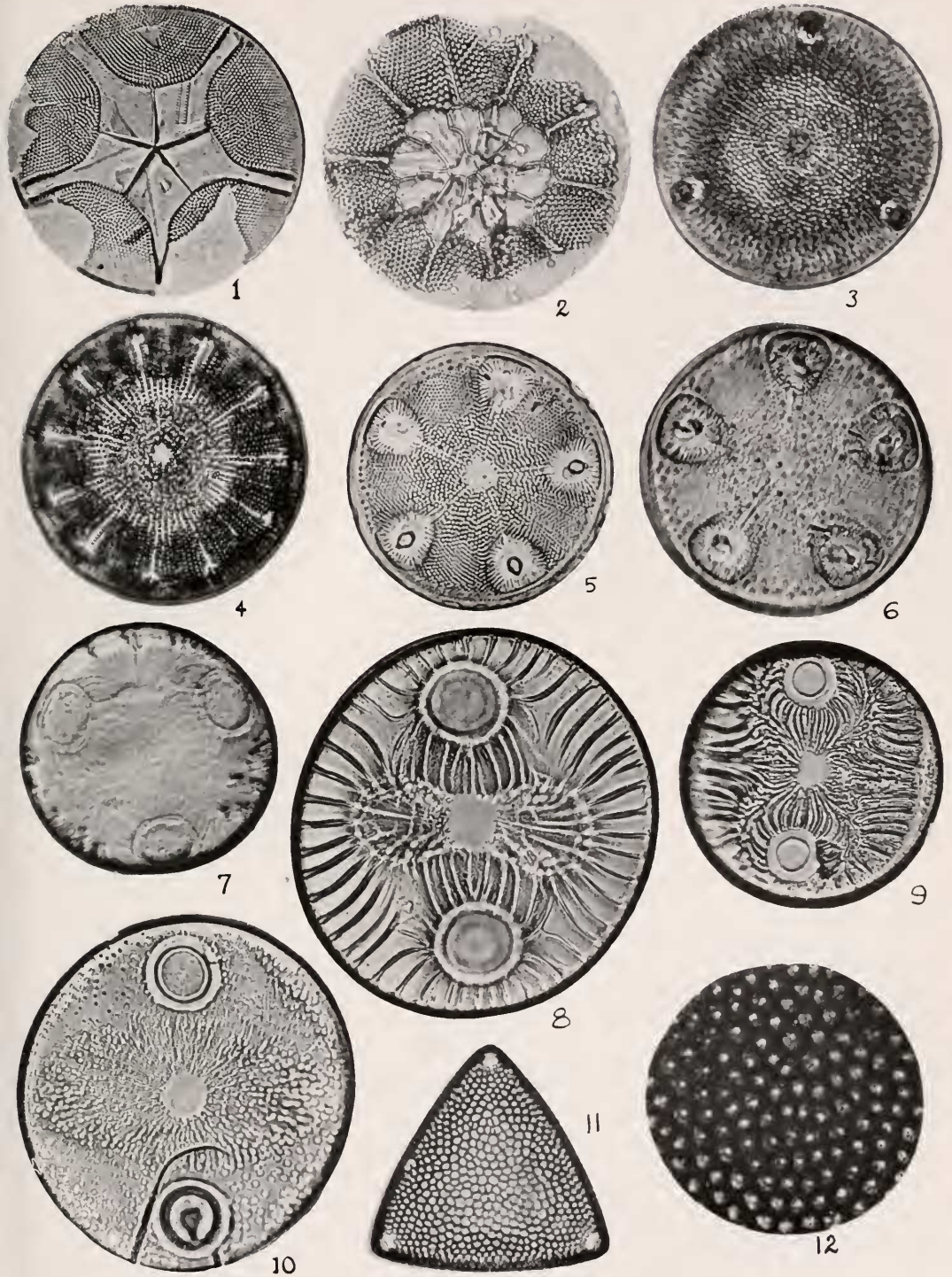


PLATE 14

- Fig. 1. *Biddulphia deodora* H. & G., n. sp. x 800. Type, No. 1900, C.A.S. coll. P. 131.
- Fig. 2. *Biddulphia deodora* H. & G., n. sp. x 920. Paratype, No. 1901, C.A.S. coll. Five pointed form; in the focal adjustment had at the time the picture was taken only a faint trace of the marginal spines could be seen, the development is practically the same in both forms. P. 131.
- Fig. 3. *Biddulphia jordani* H. & G., n. sp. x 960. Type, No. 1898, C.A.S. coll. P. 131.
- Fig. 4. *Biddulphia penitens* H. & G., n. sp. x 600. Type, No. 1902, C.A.S. coll. P. 132.
- Fig. 5. *Biddulphia penitens* H. & G., n. sp. x 540. Paratype, No. 1903, C.A.S. coll. P. 132.
- Fig. 6. *Biddulphia riedyi* H. & G., n. sp. x 300. Type, No. 1904, C.A.S. coll. P. 132.
- Fig. 7. *Biddulphia tuomeyii* (Bailey.) x 450. Plesiotype, No. 1905, C.A.S. coll. P. 133.
- Fig. 8. *Campylodiscus prentissi* H. & G., n. sp. x 1000. Type, No. 1906, C.A.S. coll. P. 134.
- Fig. 9. *Cerataulus imperator* H. & G., n. sp. x 200. Type, No. 1907, C.A.S. coll. P. 134.
- Fig. 10. *Cocconcis contrerasi* H. & G., n. sp. x 1200. Type, No. 1908, C.A.S. coll. P. 135.
- Fig. 11. *Cocconcis triumphis* H. & G., n. sp. x 600. Type, No. 1909, C.A.S. coll. P. 135.
- Fig. 12. *Cocconcis triumphis* H. & G., n. sp. x 1000. Paratype, No. 1910, C.A.S. coll. P. 135.
- Fig. 13. *Cocconcis triumphis* H. & G., n. sp. x 810. Paratype, No. 1911, C.A.S. coll. P. 135.

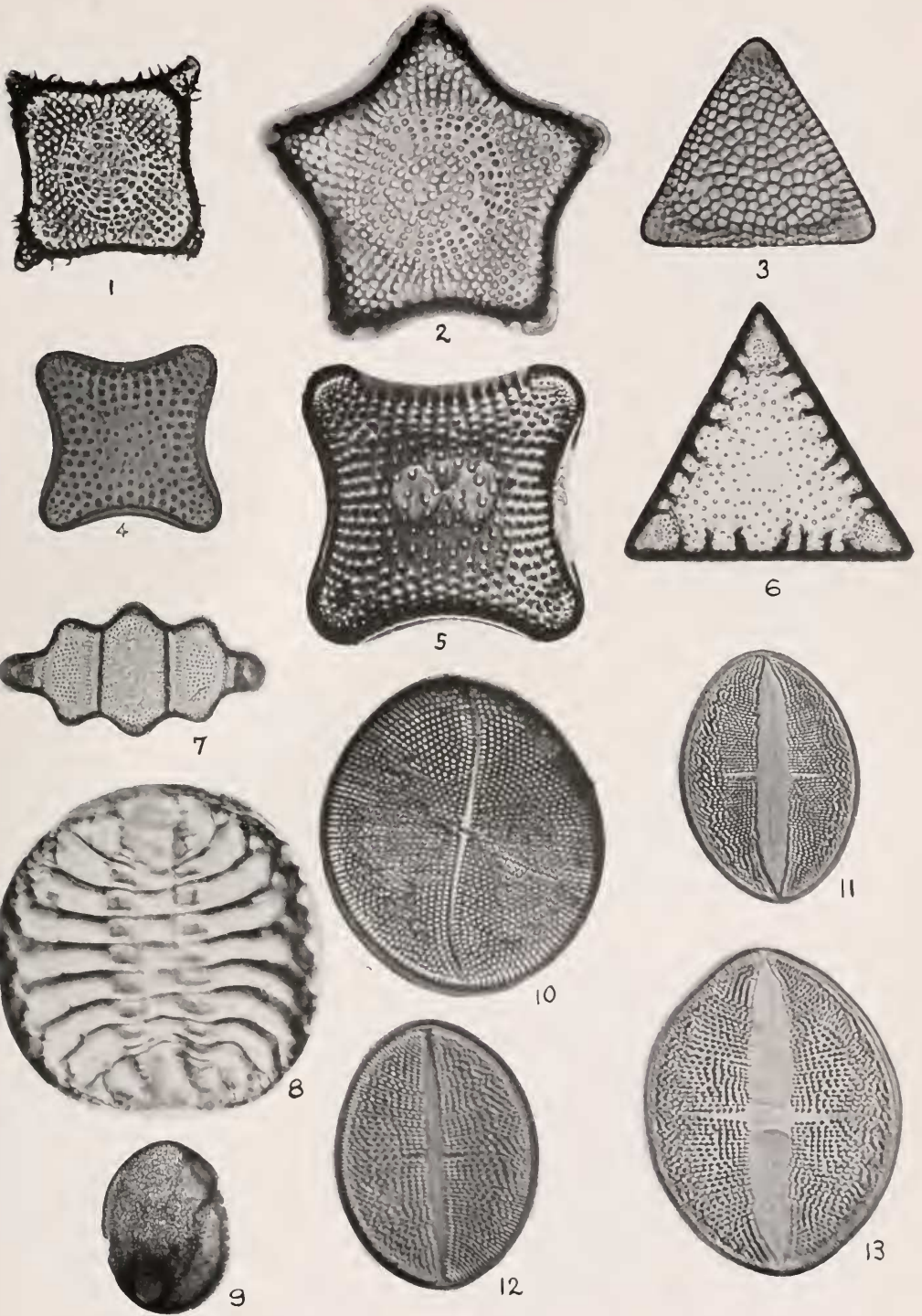
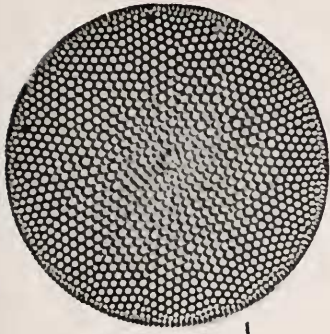
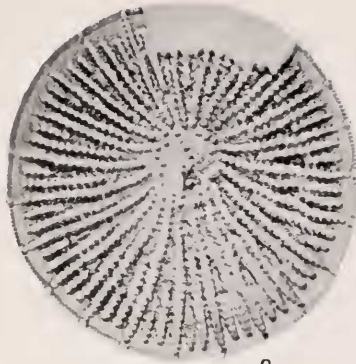


PLATE 15

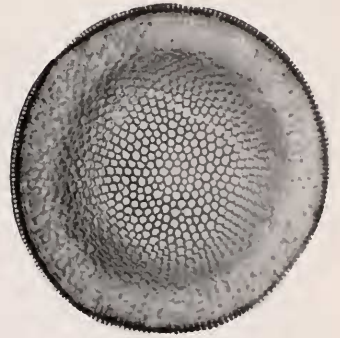
- Fig. 1. *Coscinodiscus curvatus* Grunow. x 690. Plesiotype, No. 1912, C.A.S. coll. P. 136.
- Fig. 2. *Coscinodiscus elegantulus* Greville. x 800. Plesiotype, No. 1913, C.A.S. coll. P. 136.
- Fig. 3. *Coscinodiscus evermanni* H. & G., n. sp. x 270. Type, No. 1914, C.A.S. coll. P. 137.
- Fig. 4. *Coscinodiscus fasciculatus* Schmidt. x 690. Plesiotype, No. 1917, C.A.S. coll. P. 138.
- Fig. 5. *Coscinodiscus hertleini* H. & G., n. sp. x 800. Type, No. 1918, C.A.S. coll. P. 138.
- Fig. 6. *Coscinodiscus lineatus* Ehrenberg. x 270. Plesiotype, No. 1919, C.A.S. coll. P. 139.
- Fig. 7. *Coscinodiscus marginatus* Ehrenberg. x 400. Plesiotype, No. 1920, C.A.S. coll. P. 139.
- Fig. 8. *Coscinodiscus masoni* H. & G., n. sp. x 350. Type, No. 1930, C.A.S. coll. P. 140.
- Fig. 9. *Coscinodiscus nitidus* Gregory. x 800. Plesiotype, No. 1921, C.A.S. coll. P. 140.
- Fig. 10. *Coscinodiscus nitidulus* Grunow. x 800. Plesiotype, No. 1922, C.A.S. coll. P. 141.
- Fig. 11. *Coscinodiscus oculus-iridis* Ehrenberg. x 400. Plesiotype, No. 1923, C.A.S. coll. P. 141.
- Fig. 12. *Coscinodiscus radiatus* Ehrenberg. x 400. Plesiotype, No. 1925, C.A.S. coll. P. 142.



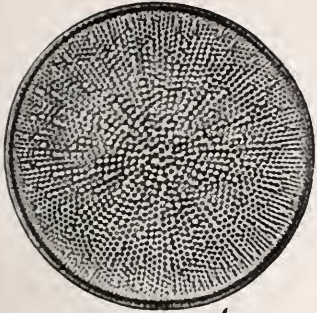
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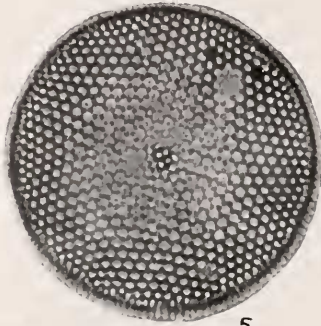
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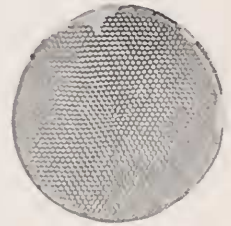
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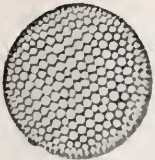
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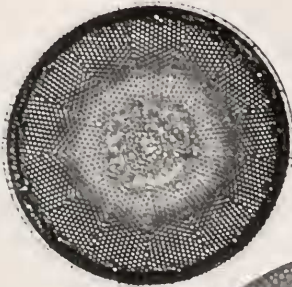
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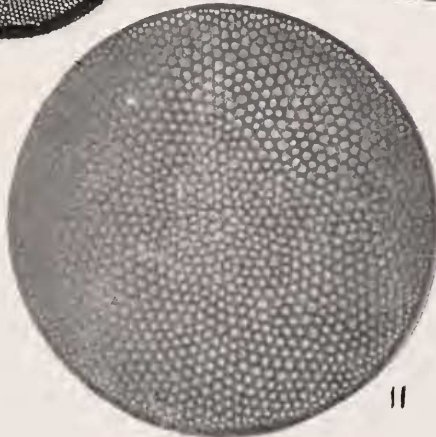
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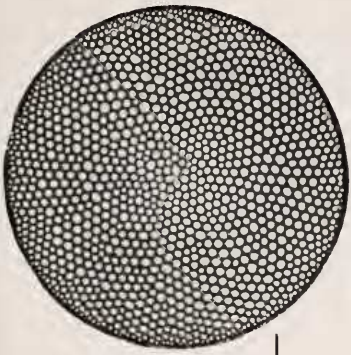
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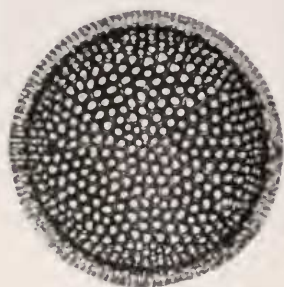
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PLATE 16

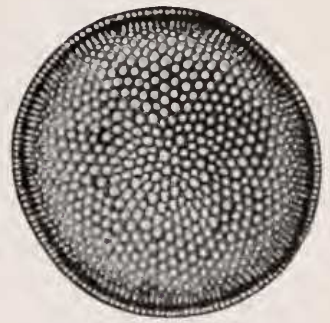
- Fig. 1. *Coscinodiscus pacificus* Grunow. x 400. Plesiotype, No. 1924, C.A.S. coll. P. 142.
- Fig. 2. *Endyctia robusta* Greville. x 375. Plesiotype, No. 1926, C.A.S. coll. P. 144.
- Fig. 3. *Endyctia robusta* Greville. x 400. Plesiotype, No. 1927, C.A.S. coll. P. 144.
- Fig. 4. *Dicladia pylea* H. & G., n. sp., x 565. Type, No. 1928, C.A.S. coll. P. 142.
- Fig. 5. *Dicladia pylea* H. & G., n. sp. x 565. Side view of type, No. 1928, C.A.S. coll. P. 142.
- Fig. 6. *Dictyoncis marginata* (Lewis.) x 570. Plesiotype, No. 1929, C.A.S. coll. P. 143.
- Fig. 7. *Eupodiscus rogersii* (Bailey.) x 350. Plesiotype, No. 1931, C.A.S. coll. P. 144.
- Fig. 8. *Eupodiscus rogersii* (Bailey.) x 330. Plesiotype, No. 1932, C.A.S. coll. P. 144.
- Fig. 9. *Glyphodesmus driveri* H. & G., n. sp. x 600. Type, No. 1933, C.A.S. coll. P. 144.
- Fig. 10. *Glyphodesmus sigmoides* H. & G., n. sp. x 1100. Type, No. 1934, C.A.S. coll. P. 145.
- Fig. 11. *Grammatophora merletta* H. & G., n. sp. x 930. Type, No. 1935, C.A.S. coll.; focused so as to show beading. P. 146.
- Fig. 12. *Grammatophora merletta* H. & G., n. sp. x 930. Same specimen as fig. 11 but in slightly different focus and with diagram of side view of interior silica-bars.
- Fig. 13. *Hemidiscus simplicissimus* H. & G., n. sp. x 960. Type, No. 1937, C.A.S. coll. P. 147.
- Fig. 14. *Grammatophora merletta* H. & G., n. sp. x 2100. A portion of paratype No. 1970a, C.A.S. coll. highly magnified to show sculpture.



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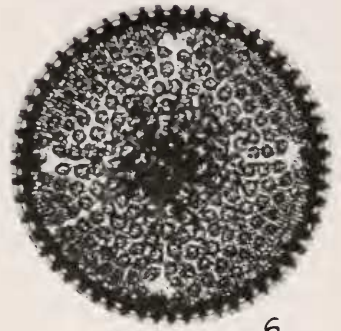


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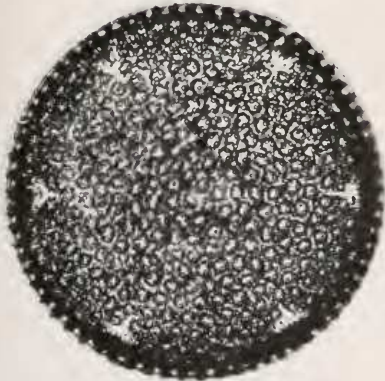


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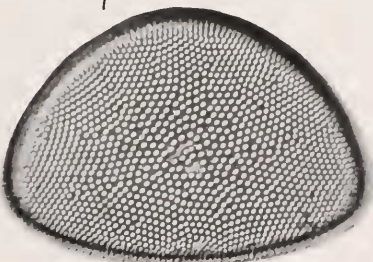
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PLATE 17

- Fig. 1. *Hemidiscus niucus* H. & G., n. sp. x 400. Type, No. 1936, C.A.S. coll. P. 146.
- Fig. 2. *Melosira sulcata* Kützing. x 485. Plesiotype, No. 1938, C.A.S. coll. P. 148.
- Figs. 3, 4. *Navicula californica* Greville. x 790. Plesiotypes Nos. 1939, 1949, C.A.S. coll. P. 148.
- Fig. 5. *Navicula campylodiscus* Grunow. x 540. Plesiotype, No. 1940, C.A.S. coll. P. 149.
- Fig. 6. *Navicula campylodiscus* Grunow. x 540. Another specimen mounted on same slide as No. 1940, C.A.S. coll.
- Fig. 7. *Navicula clavata* Gregory. x 1275. Plesiotype, No. 1941, C.A.S. coll. P. 149.
- Fig. 8. *Navicula densistriata* Schmidt. x 600. Plesiotype, No. 1942, C.A.S. coll. P. 150.
- Fig. 9. *Navicula densistriata* Schmidt. x 600. Plesiotype, No. 1943, C.A.S. coll. P. 150.
- Fig. 10. *Navicula densistriata* Schmidt. x 630. Plesiotype, No. 1944, C.A.S. coll. P. 150.
- Fig. 11. *Navicula castwoodi* H. & G., n. sp. x 400. Type, No. 1945, C.A.S. coll. P. 150.
- Fig. 12. *Navicula stippi* H. & G., n. sp. x 630. Type, No. 1947, C.A.S. coll. P. 156.

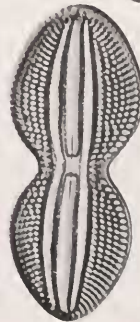
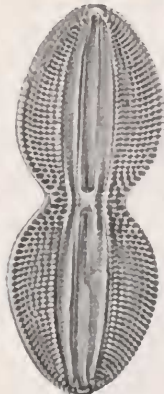
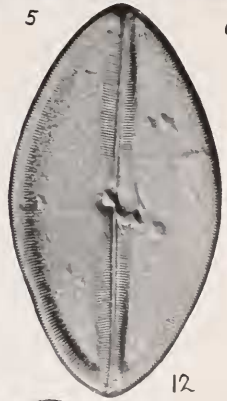
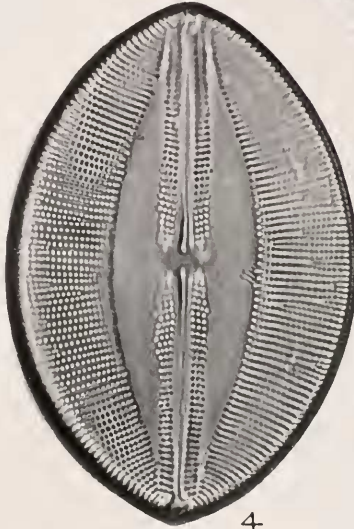
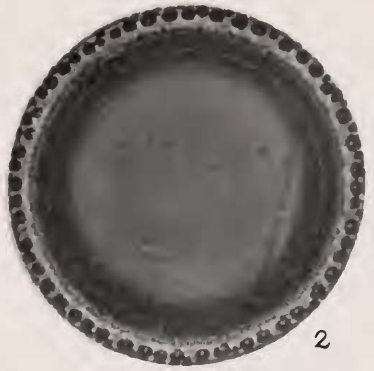
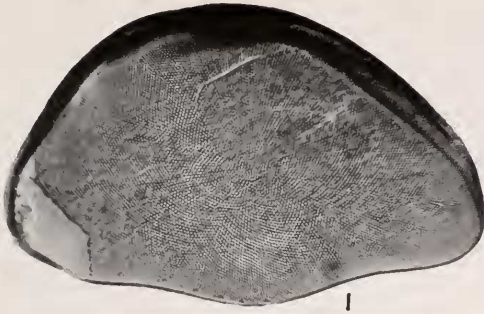


PLATE 18

- Fig. 1. *Navicula hennedyi* W. Smith. x 400. Plesiotype, No. 1950, C.A.S. coll. P. 151.
- Fig. 2. *Navicula impressa* Grunow. x 600. Plesiotype, No. 1946, C.A.S. coll. P. 151.
- Fig. 3. *Navicula longa* (Gregory.) x 540. Plesiotype, No. 1951, C.A.S. coll. P. 152.
- Fig. 4. *Navicula longa* (Gregory.) x 540. Mounted with No. 1951 showing variation in shape.
- Fig. 5. *Navicula lyra* Ehrenberg. x 600. Plesiotype, No. 1952, C.A.S. coll. P. 152.
- Fig. 6. *Navicula madrae* H. & G., n. sp. x 650. Type, No. 1953, C.A.S. coll. P. 152.
- Fig. 7. *Navicula ortolanae* H. & G., n. sp. x 540. Type, No. 1954, C.A.S. coll. P. 153.
- Fig. 8. *Navicula pandura* Brebisson. x 280. Plesiotype, No. 1948, C.A.S. coll. P. 154.
- Fig. 9. *Navicula pelagi* Schmidt. x 940. Plesiotype, No. 1955, C.A.S. coll. P. 154.
- Fig. 10. *Navicula praeexta* Ehrenberg. x 600. Plesiotype, No. 1956, C.A.S. coll. P. 154.
- Fig. 11. *Navicula praeexta* Ehrenberg. x 600. Plesiotype, No. 1957, C.A.S. coll. P. 154.
- Fig. 12. *Navicula praeexta* Ehrenberg. x 500. Plesiotype, No. 1958, C.A.S. coll. P. 154.
- Fig. 13. *Navicula rcygate* H. & G., n. sp. x 1125. Type, No. 1959, C.A.S. coll. P. 155.

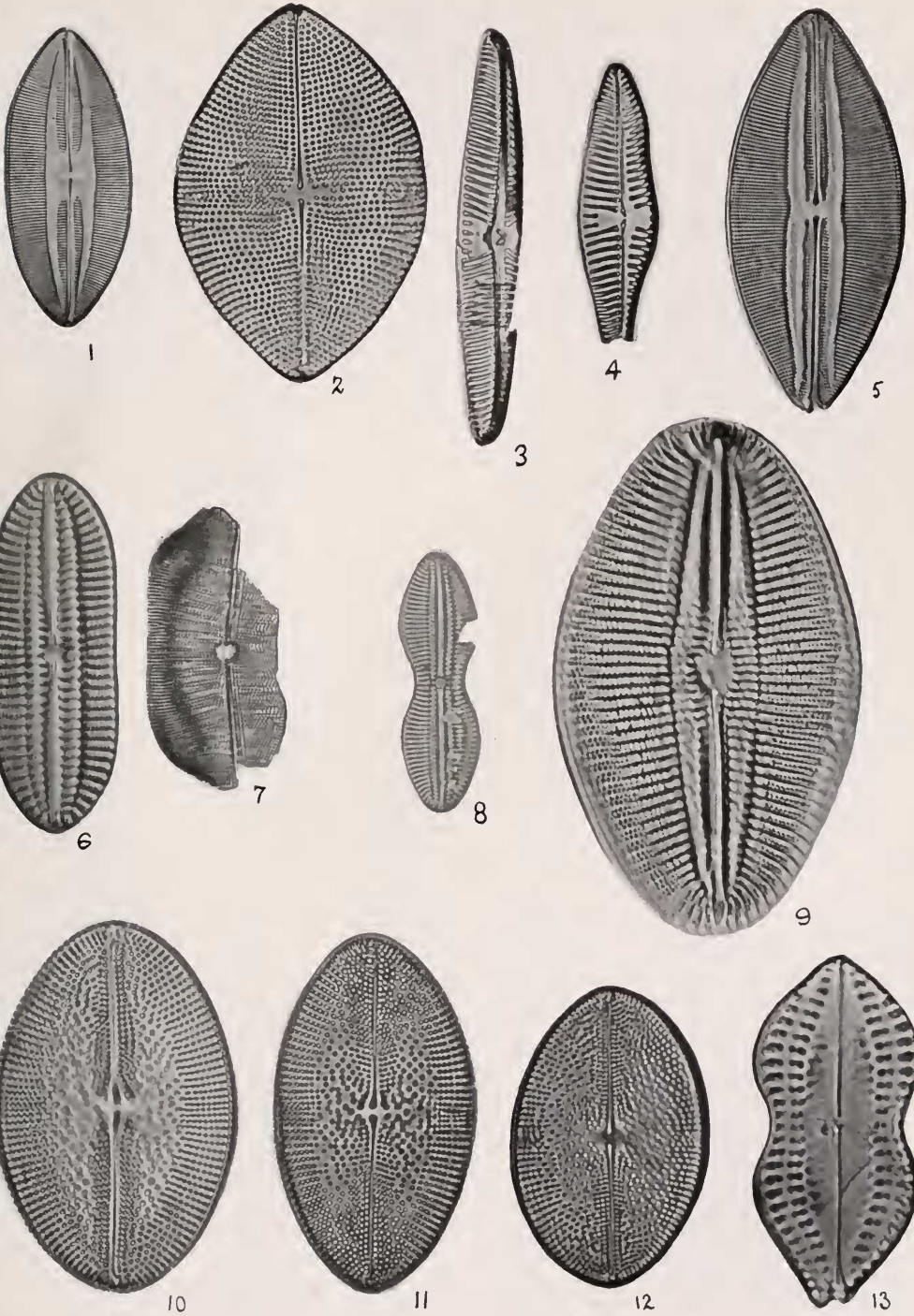
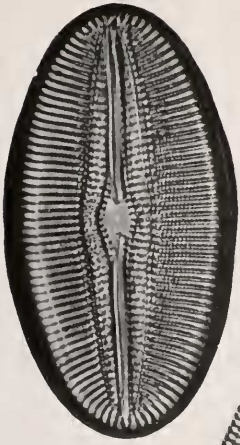
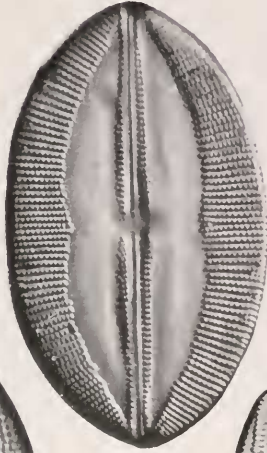


PLATE 19

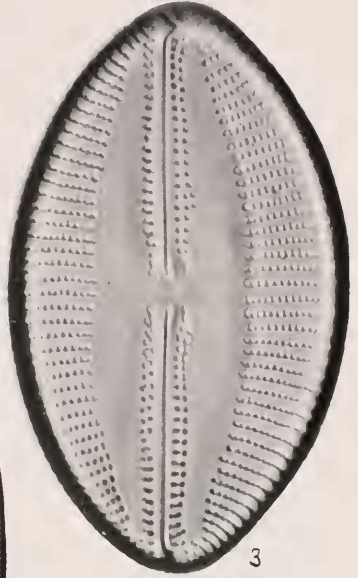
- Fig. 1. *Navicula smithii* Brebisson. x 630. Plesiotype, No. 1960, C.A.S. coll. P. 155.
- Fig. 2. *Navicula spectabilis* Gregory. x 920. Plesiotype, No. 1961, C.A.S. coll. P. 156.
- Fig. 3. *Navicula subspectabilis* H. & G., n. sp. x 1530. Type, No. 1962, C.A.S. coll. P. 157.
- Fig. 4. *Navicula splendida* Gregory. x 530. Plesiotype, No. 1948a, C.A.S. coll. P. 156.
- Fig. 5. *Navicula vidovichii* Grunow. x 600. Plesiotype, No. 1963, C.A.S. coll. P. 158.
- Fig. 6. *Orthoncis splendida* (Gregory.) x 880. Plesiotype, No. 1963, C.A.S. coll. P. 160.
- Fig. 7. *Plagiogramma fascinatum* H. & G., n. sp. x 1520. Type, No. 1969, C.A.S. coll. P. 160.
- Fig. 8. *Plagiogramma hymenoptera* H. & G., n. sp. x 640. Type, No. 1970, C.A.S. coll. P. 161.
- Fig. 9. *Plagiogramma insolito* H. & G., n. sp. x 720. Type, No. 1971, C.A.S. coll. P. 161.
- Fig. 10. *Plagiogramma tessellatum* Greville. x 380. Plesiotype, No. 1973, C.A.S. coll. P. 162.
- Fig. 11. *Pleurosigma manni* H. & G., n. sp. x 800. Type, No. 1974, C.A.S. coll. Central portion photographed to show sculpture; see next plate for outline of valve. P. 162.



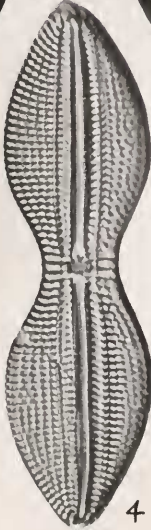
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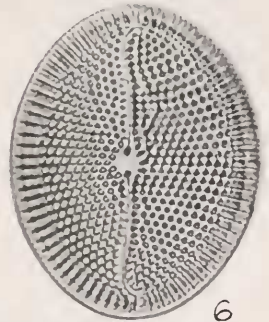
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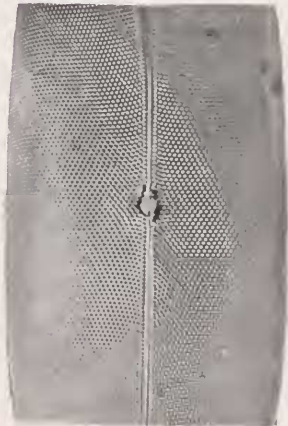
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PLATE 20

- Fig. 1. *Pleurosigma manni* H. & G., n. sp. x 450. Type, No. 1974, C.A.S. coll. Outline of valve; see preceding plate for details of sculpture.
- Fig. 2. *Podosira adriatica* (Kützing.) x 800. Plesiotype, No. 1975, C.A.S. coll. P. 163.
- Fig. 3. *Podosira clarki* H. & G., n. sp. x 800. Type, No. 1976, C.A.S. coll. P. 163.
- Fig. 4. *Podosira ovoidca* H. & G., n. sp. x 800. Type, No. 1977, C.A.S. coll. P. 163.
- Fig. 5. *Podosira polita* H. & G., n. sp. x 900. Type, No. 1978, C.A.S. coll. P. 164.
- Fig. 6. *Porpeia quadriceps* Bailey. x 400. Plesiotype, No. 1979, C.A.S. coll.; side view. P. 164.
- Fig. 7. *Porpeia quadriceps* Bailey. x 400. End view of another individual mounted on same slide as No. 1979.
- Fig. 8. *Rhaphoneis ampiceros* Ehrenberg. x 1200. Plesiotype, No. 1980, C.A.S. coll. P. 165.
- Fig. 9. *Rhaphoneis cocconeiformis* (Schmidt.) x 1200. Plesiotype, No. 1981, C.A.S. coll. P. 165.
- Fig. 10. *Stephanogonia pretiosa* H. & G., n. sp. x 400. Type, No. 1982, C.A.S. coll. P. 166.
- Fig. 11. *Stephanopyxis corona* (Ehrenberg.) x 400. Plesiotype, No. 1983, C.A.S. coll. P. 166.
- Fig. 12. *Stictodiscus californicus* Greville. x 570. Plesiotype, No. 1984, C.A.S. coll. P. 167.

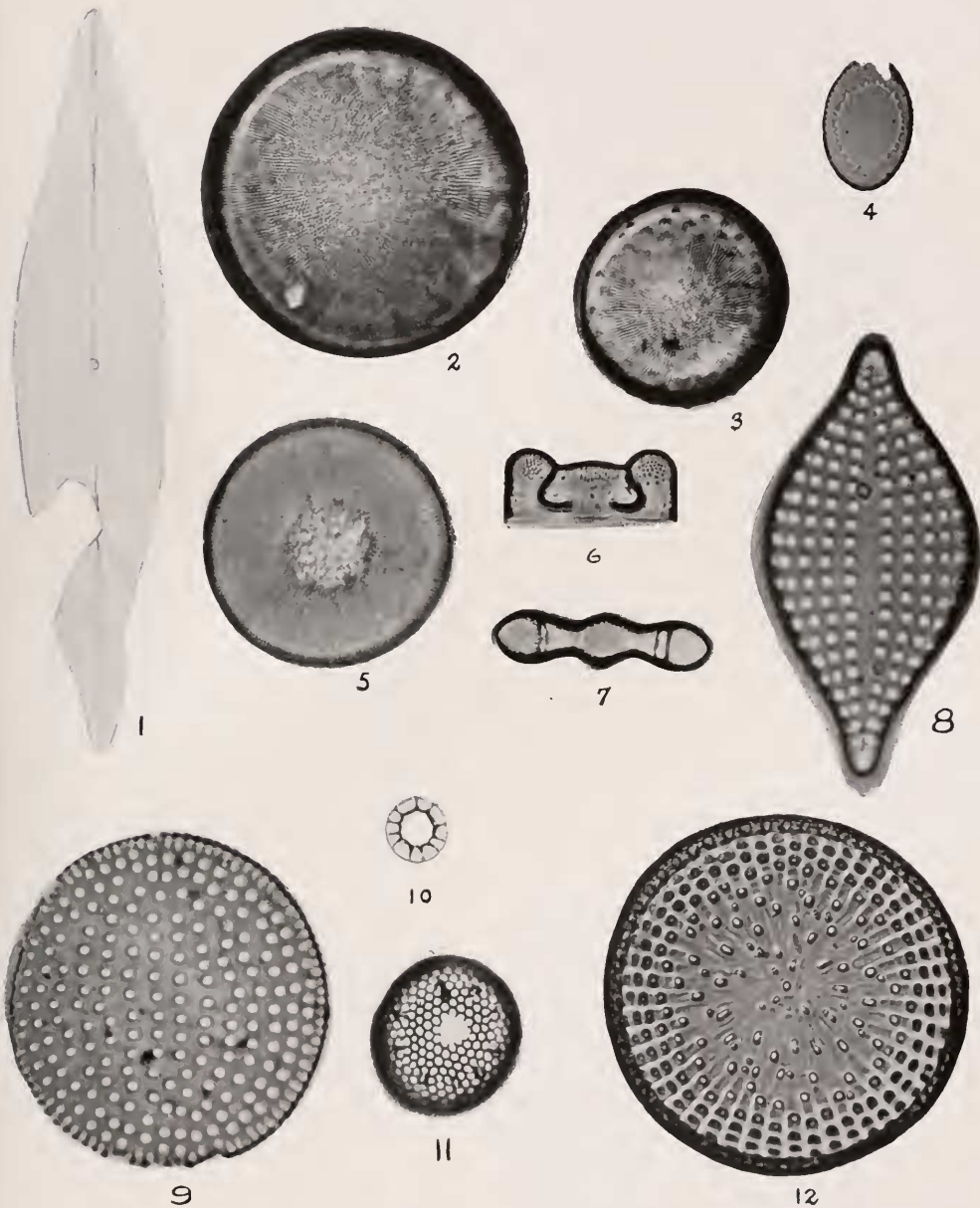


PLATE 21

- Fig. 1. *Surirella newmani* H. & G., n. sp. x 790. Type, No. 1985, C.A.S. coll. P. 167.
- Fig. 2. *Surirella patens* Schmidt. x 790. Plesiotype, No. 1986, C.A.S. coll. P. 168.
- Fig. 3. *Synedra duhemi* H. & G., n. sp. x 480. Type, No. 1987, C.A.S. coll.; diagrammatic cross section at *a*. P. 168.
- Fig. 4. *Trachyncis aspera* (Ehrenberg.) x 600. Plesiotype, No. 1988, C.A.S. coll. P. 169.
- Fig. 5. *Nitzschia honoensis* H. & G., n. sp. x 450. Type, No. 1964, C.A.S. coll. P. 158.
- Fig. 6. *Nitzschia nelsoni* H. & G., n. sp. x 600. Type, No. 1965, C.A.S. coll. P. 159.
- Fig. 7. *Nitzschia nelsoni* H. & G., n. sp. x 450. Paratype, No. 1966, C.A.S. coll. P. 159.
- Fig. 8. *Nitzschia princeps* H. & G., n. sp. x 400. Type, No. 1967, C.A.S. coll. P. 159.
- Fig. 9. *Xanthiopyxis cingulata* Ehrenberg. x 1000. Plesiotype, No. 1989, C.A.S. coll. P. 169.
- Fig. 10. *Xanthiopyxis hirsuta* H. & G., n. sp. x 1200. Type, No. 1990, C.A.S. coll. P. 170.
- Fig. 11. *Xanthiopyxis oblonga* Ehrenberg. x 800. Plesiotype, No. 1991, C.A.S. coll. P. 170.

